MACHINERY'S DATA SHEETS

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No. 9

Springs, Slides and Machine Details

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CONTENTS

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MACHINERY'S DATA SHEET SERIES

COMPILED FROM MACHINERY'S MONTHLY DATA SHEETS AND ARRANGED WITH EXPLANATORY NOTES

No. 9

Springs, Slides and Machine Details

CONTENTS

In the following pages are compiled a number of diagrams and concise tables relating to springs, slides and other machine details, carefully selected from MACHINERY'S monthly Data Sheets, issued as supplements to the Engineering and Railway editions of MACHINERY since September, 1898.

In order to enhance the value of the tables and diagrams, brief explanatory notes have been provided wherever necessary. In these notes references are made to articles which have appeared from time to time in MACHINERY, and to matter published in MACHINERY'S Reference Series, giving additional information on the subject. These references will be of considerable value to readers who wish to make a more thorough study of the subject. In a note at the foot of each table reference is made to the page on which the explanatory note relating to the table appears.

SPRINGS

Formulas for Spring Calculations

On pages 4, 5 and 7 are given a number of formulas for various classes of springs. By means of these formulas it is comparatively easy to ascertain to what load any given spring may be subjected, with a given deflection. On page 5 the necessary explanation of the formulas on pages 4 and 5 is given. On page 7 is also given a summary of compression tests on coil springs, made by Prof. C. H. Benjamin, at the Case School of Applied Science, Cleveland, Ohio. [MACHINERY, May, July and August, 1898, What a Machine Designer should know about Springs; January, 1910, Railway Edition, The Design of Heavy Helical Springs for Railroad Cars; January, 1910, Engineering Edition, The Design of Automobile Springs; July, 1910, The Design of Flat Spiral Springs; MACHINERY'S Reference Series No. 58, Helical and Elliptic Springs.]

Tables for Spring Calculations

The tables on pages 8 to 11, inclusive, give the greatest allowable pressure or load in pounds, and the corresponding compression or deflection in inches per coil of helical springs of various sizes. The same values for helical springs of square steel with the length of the side equal to the diameter of the round steel, may be found by multiplying the greatest allowable loads for round stock by 1.2 and the deflections by 0.59.

It is proper to state in the beginning that helical springs are not spiral springs, as they are so often miscalled by the majority of mechanics, and even by mechanical engineers. A spiral spring is one in which the coils lie in the same plane, being wound around a center and continually receding from it the same as a watch spring. A helical spring is one that is wound around an arbor, advancing like the thread of a screw. A volute spring, in a sense, might be said to be a combination of the two, being shaped like a cone.

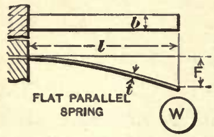
As will be seen from the tables, the values given therein are for springs made of a good quality spring steel, varying in fiber strength from 80,000 to 150,000 pounds per square inch of section, and a torsional modulus of elasticity of 10,500,000. The maximum fiber strength of the larger sizes of common spring wire or rods has been shown by repeated tests to be somewhat less than the figures given in the tables, but for the smaller sizes of wire the fiber strength obtained by test compares very favorably with the figures given. The greater strength of the small size of spring wire, no doubt, is due to the fact that it is drawn from large stock, each draft increasing its strength because of the refining effect of the dies on the surface of the metal. In the large sizes, the proportionate increase of strength due to the refined metal is not so much. In fact, large sizes of helical springs often are made from rods or bars taken directly from the rolling mill.

The notes given in the lower part of the table on page 11 should be noted before using the tables. In the body of the tables two lines of figures are given opposite each diameter of wire. The upper line gives the greatest allowable pressure in pounds and the lower line the corresponding compression per coil in inches.

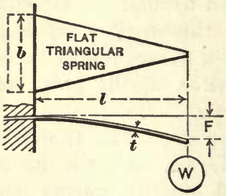
The tables are based on the J. W. Cloud adaptation of spring formulas given in "Kent's Mechanical Engineer's

(Continued on page 6.)

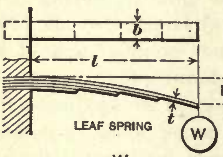
FORMULAS FOR STRENGTH AND DEFLECTION OF COMMON SPRINGS—I

1. 

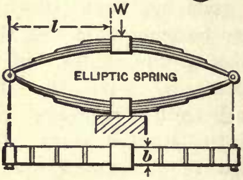
$$W=\frac{Cbt^2}{l};\quad F=\frac{Wl^3}{Kbt^3};\quad F=\frac{Cl^2}{Kt}$$

2. 

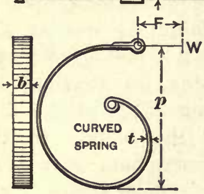
$$W=\frac{Cbt^2}{l};\quad F=\frac{3\,Wl^3}{2\,Kbt^3};\quad F=\frac{3\,Cl^2}{2\,Kt}$$

3. 

$$W=\frac{Cnbt^2}{l};\quad F=\frac{3\,Wl^3}{2\,Knbt^3};\quad F=\frac{3\,Cl^2}{2\,Kt}$$

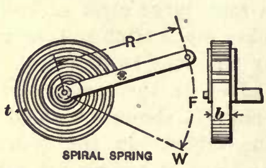
4. 

$$W=\frac{2\,Cnbt^2}{l};\quad F=\frac{3\,Wl^3}{2\,Knbt^3};\quad F=\frac{3\,Cl^2}{Kt}$$

5. 

$$W=\frac{Cbt^2}{p};\quad F=\frac{9\,Wp^3}{2\,Kbt^3};\quad F=\frac{9\,Cp^2}{2\,Kt}$$

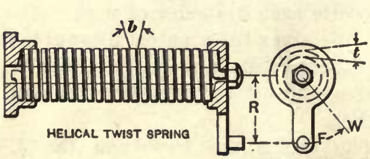
THE FIVE FORMULAS FOLLOWING ARE FOR BOTH SPRINGS 6 AND 7*

6. 

$$W=\frac{Cbt^2}{R};\quad F=\frac{3\,WlR^2}{Kbt^3}\ \text{for flat and square steel.}$$

$$W=\frac{3\,Cd^3}{5\,R};\quad F=\frac{5\,WlR^2}{Kd^4}\ \text{for round steel; } d=\text{diam. of rod.}$$

$$U=\frac{7\,Cl}{15\,Kt}\ \text{for flat, square or round steel,}$$

7. 

Machinery, N.Y.

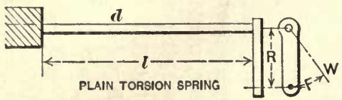
in which $U=$ the deflection expressed in revolutions of the lever, and $l=$ the length of the uncoiled spring.

* These formulas are not mathematically correct unless the end of the spring is firmly attached to the lever.

Contributed by J. Begtrup, MACHINERY'S Data Sheet No. 3. Explanatory note: Page 3.

FORMULAS FOR STRENGTH AND DEFLECTION OF COMMON SPRINGS—II

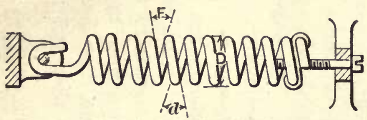
8.



PLAIN TORSION SPRING

$$\begin{cases} W = \dfrac{Z\,d^3}{5\,R}; \quad F = \dfrac{10\,W\,R^2\,l}{G\,d^4}; \quad F = \dfrac{2\,Z\,l\,R}{G\,d} \text{ for round rod.} \\ W = \dfrac{Z\,d^3}{4\,R}; \quad F = \dfrac{6\,W\,R^2\,l}{G\,d^4}; \quad F = \dfrac{\sqrt{2}\,Z\,l\,R}{G\,d} \text{ for square rod.} \end{cases}$$

9.



HELICAL EXTENSION SPRING

Machinery, N.Y.

$$\begin{cases} W = \dfrac{40\,Z\,d^3}{100\,(D-d)}; \quad F = \dfrac{8\,W\,(D-d)^3}{G\,d^4}; \quad F = \dfrac{314\,Z\,(D-d)^2}{100\,G\,d} \text{ for round steel.} \\ W = \dfrac{47\,Z\,d^3}{100\,(D-d)}; \quad F = \dfrac{47\,W\,(D-d)^3}{10\,G\,d^4}; \quad F = \dfrac{222\,Z\,(D-d)^2}{100\,G\,d} \text{ for square steel.} \end{cases}$$

EXPLANATION OF FORMULAS

W is the load, pull or pressure, in pounds. In the formulas for springs 1 to 8, inclusive, F is the deflection in inches of the point of application of the load; n is the number of plates in spring 3 and in one-half of spring 4; C and K are constant factors, whose values depend on the material and working conditions; C is one-sixth of the safe unit tensile stress, and K is one-fourth of the modulus of elasticity. For untempered steel continuously working, we may put $C = 5000$, and for refined cast steel, properly tempered, $C = 10{,}000$ to $25{,}000$; $K = 6{,}000{,}000$ to $10{,}500{,}000$.

F is the deflection of one coil of spring 9.

D is the outside diameter.

Z is the safe shearing unit stress; its value depends on the material and working conditions. For untempered steel continuously working, $Z = 25{,}000$ to $35{,}000$, and for refined cast steel properly tempered, $Z = 60{,}000$ to $120{,}000$.

G is the torsional modulus of elasticity; it may vary from 11,000,000 to 14,000,000; 12,000,000 is a fair mean value.

The formulas for helical extension springs may be used for helical compression springs.

Simple and Useful Rules

The safe load for springs 1 to 7 varies as the square of the thickness of the spring, and varies inversely as the length.

The safe deflection of all springs varies inversely as the thickness.

The safe deflection of springs 1, 2, 3, 4 and 5 varies as the square of the length.

The safe load for springs 6, 7 and 8 is independent of the length of the spring, and the safe deflection varies directly as the length.

The safe load for spring 9 varies inversely as the mean diameter of the coil and the safe deflection varies as the mean diameter squared; and with a given mean diameter it varies inversely as the thickness.

The numerical factors in these formulas are not mathematically correct, but they are sufficiently accurate for practical calculations.

Contributed by J. Begtrup, MACHINERY'S Data Sheet No. 3. Explanatory note: Page 3.

Pocketbook" on page 351, where

$$P = \frac{S \pi d^3}{16R}; \text{ and } f = \frac{32 P R^2 l}{G \pi d^4}$$

In which

P = load on spring,

S = maximum shearing fiber stress in bar,

d = diameter of wire or rod,

R = radius of spring, measured to center of wire,

l = length of rod before coiling,

G = modulus of shearing elasticity,

f = deflection of spring under load.

The second formula becomes, on substituting for P its value in terms of S:

$$f = \frac{2 R S l}{d G};$$

and neglecting the difference between the circumference of a circle and one coil of a helix, it can be written:

$$f = \frac{64 P R^3}{d^4 G}.$$

A large number of tests were recently made with springs of various sizes of wire and diameters of coil to determine the accuracy of these formulas and of the tables compiled. On the whole the formulas and tables derived were found to be very close to the average results, especially on springs made from small wire.

The load for a spring, as given in the tables, is the greatest allowable pressure; therefore, a factor of safety should be used for all spring installation, depending on the nature of the service. A spring being made of elastic material and of such shape as will permit of great relative deflection, will not be affected by sudden shocks or blows to the same extent as a rigid body. Consequently, a factor of safety very much less than for the rigid members of a machine body may be employed. The factor of safety varies, of course, according to the service, and the following is considered good practice. For no vibration, use a factor 1.5; for moderate vibration, 2; and for incessant vibration, 3. To illustrate the use of the tables, a few examples will be given.

Example 1: What is the greatest allowable load for a spring made of ¼ inch round wire, 1¾ inch outside diameter? The mean diameter of the spring, which corresponds to the pitch diameter of a gear, is the outside diameter minus the diameter of the wire, and in this case is, 1¾ inch — ¼ inch = 1½ inch. From the table on page 9 we find that the greatest allowable pressure or load is 513 pounds, and that the deflection is 0.338 inch per coil.

Example 2: Assuming that the foregoing spring has 15 coils, close-wound, how much is the extension under a load of 513 pounds? In calculating the deflection, we consider the two end coils as inoperative; this then leaves 13 working coils, and the entire deflection of the spring would be 13×0.338 inch = 4.394 inches.

Example 3: A spring made of ½-inch round wire, close wound, and 4 inches mean diameter, is used in tension subject to moderate vibration where the load is not known. How can it be ascertained whether the spring is overloaded or not? Referring to the table on page 10, we find that the maximum deflection per coil of a spring of the given diameter is 1.040 inch. If the opening between the coils is less than $1.040 \div 2 = 0.520$ inch (2 being the factor of safety for moderate vibration), the spring is safe. The deflection always is directly proportionate to the load. For example, what will be the deflection of a spring 6 inches mean diameter, made of ¾-inch round wire, when carrying a load of 1000 pounds? From the table on page 10, we find that with a load of 2770 pounds, the deflection per coil is 1.440 inch; then for 1000 pounds the deflection per coil would be $\frac{1.440 \times 1000}{2770} = 0.520$ inch.

(Continued on page 24.)

FORMULAS FOR COIL SPRINGS

L = length of axis of spring.
l = developed length of wire $= \sqrt{\pi^2 D^2 n^2 + L^2}$
D = mean diameter of spring = outside diameter − diameter of wire $= D^1 - d$.
d = diameter of wire (length of side of square wire).
n = number of coils.
S = safe torsional or shearing strengh of wire. 25,000 for spring brass. (See table below for steel.)
G = modulus of torsional elasticity. 6,000,000 for spring brass, 12,000,000 to 18,000,000 for steel.
P = safe working load.
X = Safe deflection.

For Round Wire.

$$P = \frac{S d^3}{2.55 D}$$

$$X = \frac{l D S}{G d}$$

For Square Wire.

$$P = \frac{S d^3}{2.12 D}$$

$$X = \frac{l D S}{G d \sqrt{2}}$$

COMPRESSION TESTS ON COIL SPRINGS.

SUMMARY OF TESTS MADE BY PROF. C. H. BENJAMIN, AT THE CASE SCHOOL OF APPLIED SCIENCE.

The object of the tests was to find the coefficient of torsional elasticity and the safe stress for springs made of different sizes of bars and having different ratios of diameter of spring to diameter of bar.

The value for G, the coefficient of torsional elasticity, is given in most hand-books as 12,000,000. In these tests the values ranged higher than this, the highest value being 18,900,000 and the lowest 12,500,000. This variation is due both to variation in temper and to slight differences in the chemical constituents of the steel. The average of all the tests is found to be 14,700,000, which may be written 14,500,000 for convenience. The size of bar has much to do with the safe value of S, the torsional stress in pounds per square inch, since it is not possible to work a large bar so that it will be as homogeneous as a small bar. Springs of small diameter may be safely subjected to a higher stress than those of large diameter, but the proportions should not be carried to an extreme, and a spring to have good service should have a mean diameter not less than three times the diameter of the bar.

For a good grade of steel the following values of S have been found safe under ordinary conditions of service, the value of G being taken as 14,500,000. The ratio of the mean diameter of spring to the diameter of bar is expressed by R in the following:

For bars below ⅜ inch diameter:

$R = 3$ $S = 112,000$
$R = 8$ $S = 85,000$

For bars 7-16 to ¾ inch in diameter:

$R = 3$ $S = 110,000$
$R = 8$ $S = 80,000$

For bars from 13 16 to 1¼ inches in diameter:

$R = 3$ $S = 105,000$
$R = 8$ $S = 75,000$

For bars over 1¼ inches in diameter a stress of more than 100,000 should not be used. Where a spring is subjected to sudden shocks a smaller value of S is necessary.

The springs referred to in this paper are all compression springs with open coils. Experience has shown that in close coil or extension springs the value of G is the same, but that the safe value of S is only about two-thirds that for a compression spring of the same dimensions.

ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL—I

Maximum Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil. Pitch Diameter of Spring.																		
			1/16"	3/32"	1/8"	5/32"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 5/8"
125,000	25	.020"	6.25	4.21	3.21	2.50	2.06	1.545	1.24	1.042	.895										
			.0079	.0164	.0298	.0453	.0644	.1150	.1792	.2565	.3545										
	24	.023"	9.5	6.3	4.75	3.71	3.15	2.38	1.845	1.521	1.325										
			.0063	.0141	.0262	.0382	.0503	.1011	.1528	.2173	.2991										
	23	.025"	12.28	8.15	6.08	4.9	4.025	3.05	2.5	2.065	1.74	1.52									
			.0058	.0126	.023	.0363	.0516	.0929	.1481	.2111	.2812	.3671									
	22	.028"	17.3	11.5	8.63	6.85	5.76	4.32	3.46	2.83	2.39	2.18									
			.0052	.0117	.0206	.0325	.0469	.0832	.1304	.1840	.2463	.3425									
	1/32"	.031"		15.63	12.7	9.35	7.82	5.87	4.67	3.91	3.36	2.94	2.33								
				.0106	.0205	.0293	.043	.0757	.1171	.1691	.2303	.3022	.467								
150,000	21	.032"		20.8	15.51	12.4	10.32	7.7	6.14	5.085	4.44	3.78	3.13								
				.0124	.0221	.0342	.0496	.0814	.1350	.1937	.2681	.3433	.553								
	20	.035"			20.1	16.2	13.45	10.08	8.1	6.66	5.75	4.96	4.05	3.39							
					.0199	.0313	.0448	.0799	.1251	.1773	.2435	.3139	.5158	.7259							
	19	.041"			32.6	26.2	21.65	16.2	13.04	10.85	9.27	8.1	6.52	5.35	4.57						
					.0172	.0268	.0381	.0682	.1069	.1535	.2079	.2731	.4296	.608	.8237						
	18	.047"				39.12	32.6	24.55	19.6	16.44	13.95	12.3	9.8	8.1	6.92	6.14					
						.0233	.0336	.0587	.0934	.1352	.1817	.2412	.3738	.5358	.7249	.962					
	17	.054"				59.4	49.6	37.25	29.7	24.60	21.2	18.55	14.75	12.4	10.58	9.255	8.23				
						.02	.0291	.0519	.0814	.1154	.1572	.2067	.3198	.4665	.6305	.8254	1.043				
	1/16"	.062"					74.9	56.1	44.9	37.3	32.	28.	22.4	18.63	16.1	13.95	12.5	11.22			
							.0265	.0473	.0738	.1053	.1437	.1889	.2939	.4244	.5887	.753	.9592	1.183			
	16	.063"					78.24	58.7	46.9	39.2	33.9	29.4	23.5	19.6	16.8	14.7	13.2	11.9	10.75		
							.0248	.0443	.0689	.0993	.1324	.1775	.2689	.400	.5421	.7103	.9065	1.122	1.355		
	15	.072"					117.3	80.75	70.65	58.7	50.20	43.6	35.2	29.	25.	21.9	19.5	17.5	16.05		
							.0218	.0357	.0608	.0872	.1183	.1542	.2426	.3468	.4735	.6208	.7857	.9686	1.180		
	14	.080"						121.	96.6	80.5	69.15	60.4	48.28	40.1	34.6	30.1	26.75	24.2	22.1	20.2	
								.0354	.055	.079	.1077	.1417	.2197	.3169	.433	.5638	.7096	.8855	1.0715	1.277	
140,000	13	.092"						171.	135.3	113.5	97.6	85.5	68.9	57.3	48.8	42.6	37.8	34.5	31.3	28.6	
								.0288	.0439	.0635	.0805	.1140	.1796	.2577	.3475	.4522	.5728	.7186	.8654	1.030	
	3/32"	.093"						178.	142.	118.2	99.5	89.	71.2	59.1	50.9	44.3	39.6	35.7	32.3	29.0	27.3
								.0283	.0438	.0631	.0842	.1132	.1763	.2532	.3460	.4510	.5708	.710	.8529	1.017	1.193
	12	.105"							204.	170.	146.	127.5	102.	85.4	73.	63.4	56.0	51.1	46.3	42.6	38.9
									.0378	.0561	.0762	.1003	.1559	.2237	.3060	.389	.5010	.627	.758	.903	1.104
	11	.120"							303.	253.	217.5	190.	152.5	126.8	108.7	95.2	84.2	76.2	69.2	63.5	58.5
									.0338	.0488	.0664	.0871	.1363	.1965	.2667	.3489	.4397	.5242	.6590	.7872	.9208

Contributed by Henry L. Hanson, MACHINERY'S Data Sheet No. 107. Explanatory note: Page 3.

ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL—II

Max. Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil. Pitch Diameter of Spring.																							
			3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 5/8"	1 3/4"	1 7/8"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"	3 1/2"	3 3/4"	4"	4 1/4"
140,000	1/8"	.125"	286.	245.	214.	171.5	143.	121.9	107.3	95.	85.2	78.	71.5	65.8	60.8	57.2										
			.047	.064	.0834	.1302	.1881	.2542	.3345	.4215	.5195	.6345	.7463	.8768	1.0166	1.230										
	10	.135"	359.	309.	270.	217.	171.	154.	135.	120.	108.5	98.7	90.2	82.7	77.2	71.8	67.5									
			.043	.0589	.0774	.1210	.1655	.2359	.3185	.3911	.4894	.5841	.6979	.8572	.9568	1.081	1.240									
	9	.148"		408.	356.	285.	237.5	207.	178.	158.	142.4	130.	118.5	109.5	102.	95.	89.									
				.0537	.1058	.1100	.1589	.2127	.2825	.3563	.4410	.5376	.6345	.7440	.9194	.9936	1.130									
	5/32"	.156"		480.	418.	333.	270.	239.	208.	185.3	167.	152.2	139.	128.	119.4	111.6	104.6	92.7								
				.0513	.0672	.1042	.1464	.2055	.2674	.3386	.4196	.5066	.6036	.7056	.8266	.9428	1.076	1.357								
	8	.162"			468.	376.	311.5	276.5	234.	207.	187.5	170.8	156.	143.6	134.	125.5	117.	103.6								
					.0647	.1012	.1460	.2043	.2588	.3255	.4061	.4906	.5826	.6810	.7946	.9132	1.035	1.305								
	7	.177"			608.	487.	406.	347.	305.	270.	243.4	223.5	205.	187.6	174.2	163.4	152.5	135.5	122.							
					.0589	.092	.1398	.1799	.2366	.2979	.3721	.4501	.5372	.6132	.7242	.8354	.9467	1.198	1.480							
125,000	3/16"	.1875"			642.	522.	426.	367.	320.	288.	256.	233.	213.	197.	183.	170.	160.	142.5	128.3							
					.050	.0792	.1119	.1527	.1991	.2533	.3116	.3760	.4450	.525	.620	.700	.800	1.020	1.230							
	6	.192"			696.	556.	465.	396.	348.	309.	278.	254.	232.	214.	199.	186.	174.	154.5	139.3	126.3						
					.049	.077	.110	.149	.192	.247	.305	.365	.440	.515	.600	.695	.785	.990	1.220	1.480						
	5	.207"				694.	579.	495.	432.	385.	346.	315.2	288.	266.	247.	232.	216.	192.5	175.	158.	144.5	133.9				
						.071	.1010	.138	.1800	.239	.283	.343	.405	.470	.550	.633	.730	.910	1.130	1.370	1.650	1.920				
	7/32"	.218"				812.	678.	580.	509.	452.	408.	369.	339.	310.	291.	270.	255.	225.	204.	185.	169.5	155.9				
						.0665	.097	.132	.171	.215	.268	.322	.379	.445	.530	.595	.680	.860	1.060	1.290	1.540	1.780				
	4	.225"				895.	746.	640.	560.	498.	447.	407.	372.	345.	320.	299.	280.	248.	224.	203.	187.	172.2				
						.065	.092	.122	.165	.210	.256	.313	.365	.430	.505	.575	.663	.840	1.060	1.270	1.480	1.740				
	3	.244"				1120.	950.	811.	711.	632.	570.	527.	475.	438.	405.	381.	356.	316.	284.	259.	237.5	220.				
						.0595	.088	.116	.154	.194	.242	.295	.350	.415	.472	.550	.620	.775	.970	1.160	1.360	1.600				
	1/4"	.250"					1027.	880.	760.	685.	617.	560.	513.	476.	440.	410.	385.	342.	308.	281.	266.	236.				
							.084	.110	.147	.188	.232	.284	.338	.395	.460	.525	.598	.760	.945	1.130	1.360	1.570				
	2	.263"					1195.	1125.	895.	795.	717.	632.	598.	551.	501.	478.	448.	400.	359.	326.	298.	278.7	256.	238.		
							.079	.106	.142	.180	.223	.264	.325	.375	.435	.500	.580	.725	.910	1.080	1.290	1.540	1.760	1.950		
	9/32	.281"					1450.	1240.	1087.	969.	869.	794.	724.	665.	620.	580.	543.	482.	435.	395.	362.	335.	310.	290.4		
							.074	.100	.134	.167	.205	.253	.295	.356	.410	.473	.532	.660	.825	1.010	1.200	1.400	1.630	1.890		
	1	.283"						1264.	1110.	985.	886.	805.	740.	682.	634.	592.	564.	492.	439.	402.	370.	341.7	317.	296.6		
								099	.133	.166	.203	.252	.294	.348	.405	.465	.530	.650	.820	.950	1.190	1.390	1.620	1.860		
	1/0	.307"						1630.	1420.	1260.	1135.	1035.	945.	872.	810.	758.	710.	630.	568.	516.	473.	436.	406.	378.6	355.	334.
								.093	.121	.152	.186	.228	.272	.322	.372	.427	.490	.610	.760	.910	1.080	1.260	1.490	1.680	1.940	2.180
	5/16"	.312"							1575.	1376.	1220.	1100.	1000.	915.	845.	775.	732.	687.	610.	550.	500.	460.	421.7	392.	360.3	343.
									.084	.110	.138	.172	.208	.247	.290	.336	.386	.442	.550	.690	.830	1.000	1.150	1.330	1.540	1.780

Contributed by Henry L. Hanson, MACHINERY'S Data Sheet No. 107. Explanatory note: Page 3.

ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL—III

Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil.

Max. Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Pitch Diameter of Spring. 1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 5/8"	1 3/4"	1 7/8"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"	3 1/2"	3 3/4"	4"	4 1/4"	4 1/2"	4 3/4"	5"	5 1/4"	5 1/2"	5 3/4"	6"
115,000	2/0	.331"	1636.	1455.	1310.	1187.	1090.	1000.	932.	870.	818.	725.	653.	594.	545.	501.1	468.	436.5	410.	385.							
			.105	.130	.162	.195	.234	.273	.315	.365	.415	.520	.655	.790	.925	1.090	1.280	1.470	1.680	1.870							
	11/32"	.343"	1820.	1620.	1452.	1325.	1214.	1120.	1040.	970.	910.	808.	728.	661.	608.	560.	520.	486.	454.	428.							
			.100	.128	.155	.190	.218	.268	.308	.353	.400	.505	.625	.750	.910	1.060	1.220	1.380	1.600	1.780							
	3/0	.362"	2140.	1910.	1714.	1560.	1430.	1318.	1220	1142.	1070.	950.	858.	778.	714.	658.	612.	571.	535.	504.							
			.095	.119	.147	.180	.210	.250	.290	.333	.382	.480	.595	.720	.850	.990	1.170	1.333	1.510	1.720							
	3/8"	.375"		2110.	1940.	1730.	1580.	1458.	1354.	1265.	1185.	1058.	950.	860.	790.	732.	678.	635.	592.	560.	528.	501.					
				.113	.144	.172	.205	.240	.280	.320	.360	.460	.570	.680	.820	.965	1.100	1.280	1.450	1.640	1.840	2.05					
	4/0	.393"		2430.	2180.	1984.	1820.	1680.	1560.	1458.	1365.	1212.	1092.	990.	910.	842.	780.	730.	682.	645.	607.	577.					
				.109	.136	.165	.198	.230	.265	.308	.348	.440	.545	.650	.780	.920	1.060	1.220	1.390	1.560	1.770	1.980					
	13/32"	.406"			2400.	2170.	2000.	1840.	1710.	1600.	1500.	1330.	1200.	1090.	1000.	929.	855.	805.	750.	711.	666.	636.					
					.131	.159	.188	.220	.255	.295	.335	.420	.520	.625	.755	.890	1.000	1.120	1.330	1.530	1.670	1.840					
	5/0	.430"			2875.	2610.	2400.	2210.	2050.	1918.	1798.	1598.	1440.	1308.	1200.	1105.	1028.	964.	900.	840.	800.	755.					
					.128	.147	.182	.210	.242	.282	.323	.400	.500	.610	.725	.840	.980	1.160	1.280	1.420	1.600	1.820					
	7/16"	.437"			3000.	2730.	2500.	2310.	2140.	2000.	1880.	1665.	1500.	1365.	1250.	1159.	1074.	1004.	940.	886.	835.	793.	750.	717.			
					.123	.146	.178	.207	.241	.277	.318	.392	.492	.591	.704	.825	.958	1.000	1.250	1.400	1.580	1.760	1.960	2.150			
110,000	6/0	.460"				3065.	2800.	2580.	2400.	2230.	2100.	1865.	1680.	1530.	1400.	1293.	1200.	1118.	1058.	988.	932.	885.	840.	800.			
						.135	.162	.190	.220	.250	.287	.360	.445	.535	.645	.750	.885	.990	1.140	1.310	1.460	1.600	1.800	1.970			
	15/32"	.468"				3225.	2940.	2725.	2530.	2375.	2210.	1970.	1770.	1610.	1472.	1362.	1265.	1181.	1110.	1032.	985.	929.	885.	845.			
						.133	.158	.186	.215	.247	.280	.357	.440	.530	.638	.740	.860	.970	1.130	1.260	1.420	1.580	1.740	1.940			
	7/0	.490"				3675.	3370.	3115.	2890.	2710	2535	2245.	2025.	1840.	1690.	1563.	1445.	1355.	1268.	1195.	1125.	1069.	1015.	967.	920.	883.	
						.126	.152	.176	.205	.238	.268	.338	.415	.505	.605	.705	.830	.940	1.070	1.200	1.360	1.500	1.680	1.840	2.040	2.220	
	1/2"	.500"					3610.	3320.	3090.	2890.	2710.	2410.	2160.	1970.	1810.	1601.	1550.	1439.	1352.	1263.	1205.	1136.	1082.	1026.	985.	939.	
							.149	.172	.203	.228	.265	.330	.410	.505	.595	.695	.810	.920	1.040	1.180	1.340	1.480	1.660	1.820	2.000	2.200	
	9/16"	.562"						4700.	4390.	4090.	3830.	3420.	3080.	2790.	2565.	2359.	2190.	2055.	1913.	1804.	1710.	1610.	1535.	1458.	1395.	1330.	1280.
								.154	.179	.208	.232	.295	.365	.442	.530	.615	.750	.820	.925	1.060	1.180	1.305	1.460	1.600	1.767	1.910	2.100
	5/8"	.625"							6100.	5600	5260.	4660.	4210.	3825.	3505.	3242.	3000.	2812.	2630.	2480.	2340.	2216.	2110.	2000.	1913.	1830.	1750.
									.163	.184	.200	.261	.328	.394	.472	.552	.642	.737	.844	.948	1.060	1.180	1.317	1.500	1.600	1.730	1.880
100,000	11/16"	.687"									6375.	5650.	5090.	4630.	4250.	3934.	3625.	3409	3195.	2992.	2825.	2669.	2560.	2425.	2330.	2214.	2125.
											.174	.218	.272	.327	.390	.460	.530	.610	.695	.790	.875	.970	1.090	1.200	1.330	1.450	1.560
	3/4"	.750"										7400.	6640.	6030.	5540.	5096.	4745.	4418.	4150.	3897.	3690.	3486.	3325.	3150.	3025.	2880.	2770.
												.203	.250	.303	.362	.420	.490	.558	.630	.720	.820	.905	1.000	1.110	1.220	1.320	1.440
	13/16"	.812"											8420.	7660.	7000.	6496.	6010.	5631	5260.	4940.	4675.	4425.	4200.	4000.	3825.	3655.	3500.
													.228	.278	.330	.388	.445	.515	.585	.665	.740	.825	.915	1.080	1.100	1.230	1.320
	7/8"	.875"											10530.	9550.	8700.	8111.	7500.	7015.	6560.	6190.	5740.	5530.	5250.	5000.	4770.	4575.	4370.
													.210	.255	.305	.360	.418	.480	.540	.620	.682	.765	.855	.950	1.030	1.130	1.220

Contributed by Henry L. Hanson, MACHINERY's Data Sheet No. 107. Explanatory note: Page 3.

ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL—IV

Maximum Fiber Stress	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil. Pitch Diameter of Spring.													
		2 3/4"	3"	3 1/4"	3 1/2"	3 3/4"	4"	4 1/4"	4 1/2"	4 3/4"	5"	5 1/4"	5 1/2"	5 3/4"	6"
90,000	15/16"	10600.	9700.	8976.	8400.	7780.	7160.	6840.	6470.	6119.	5810.	5536.	5290.	5050.	4850.
		.2200	.2580	.3030	.3530	.4050	.4500	.5250	.5800	.6450	.7150	.7850	.8700	.9450	1.030
	1"		11780.	10874.	10100.	9424.	8800.	8316.	7850.	7440.	7050.	6732.	6330.	6150.	5870.
			.2450	.2720	.3300	.3780	.4250	.4900	.5400	.6000	.6700	.7400	.8000	.8900	.9600
	1 1/8"				14400.	13085.	12600.	11670.	11230.	10400.	10100.	9450.	9200.	8600.	8400.
					.2900	.3250	.3800	.4250.	.4850	.5280	.6000	.6450	.7250	.7800	.8350
	1 1/4"				19700.	18400.	17200.	16240.	15300.	14500.	13700.	13100.	12540.	12000.	11500.
					.2620	.3030	.3480	.3840	.4350	.4800	.5350	.5900	.6450	.7150	.7800
80,000	1 3/8"					21800.	20400.	19000.	18100.	17000.	16150.	15380.	14850.	14000.	13600.
						.2450	.2750	.3100	.3500	.3850	.4350	.4700	.5250	.5700	.6250
	1 1/2"					27150.	26500.	25440.	23500.	22300.	21400.	20300.	19300.	18200.	17700.
						.2150	.2550	.2950	.3200	.3550	.4050	.4350	.4800	.5200	.5750

These tables are based on: Maximum Fiber Stress 80,000 to 150,000 Lbs. Per Square Inch, Torsional Modulus of Elasticity 10,500,000.

For no vibration multiply actual load by 1.5, for moderate vibration multiply actual load by 2, for incessant vibration multiply actual load by 3, and select resultant pressure in table.

In calculating deflection consider 2 coils as ineffective.

For helical springs of square steel multiply load by 1.2 and deflection by 0.59.

HELICAL SPRING TABLES.

The following tables are intended to give the solid load and ratio of free height to solid height for all practical varieties of helical springs. Springs designed by these tables will come solid at a fiber stress of 80,000 pounds per square inch (torsional) in the bar, equivalent to 100,000 pounds direct stress. (In practice the solid load will generally be from 5 to 15 per cent greater than the stated values, which are deduced theoretically, and are based on a maximum stress of 80,000 pounds.) The most generally preferred ratio for size is: $D = 5d$, where D is outside diameter of coil. The free height for any solid height can be found by simple addition, using the values under the nine digits. Thus free height of spring of $1\frac{1}{16}''$ steel, 4″ outside diameter and 12″ solid height =

Value under 1 (point moved to right).. 14.6
" " 2.. 2.93

Free Height.. 17.53

It is customary to make the static load about one-half the solid load. The following formulas were used in constructing the tables:

D = outside diameter of coil, in inches.
P = load when spring is down solid, in pounds.
S = maximum shearing fiber stress in bar, taken at 80,000 pounds.
d = diameter of steel, in inches.
R = radius of center of coil, in inches.
L = length of bar before coiling, in inches.
G = modulus of shearing elasticity taken at 12,600,000 pounds.
f = deflection of spring under load, in inches.
H = height of spring, free, in inches.
h = height of spring solid, in inches.
$\pi = 3.1416$.

Then

$$P = \frac{S \pi d^3}{16 R} \qquad f = \frac{32 P R^2 L}{G \pi d^4} \qquad h = \frac{L d}{2 \pi R} \text{ and } H = h + f$$

Eliminating and reducing we have, $f = \dfrac{4 S \pi R^2 H}{d^3 \quad G d^2}$, and substituting the proper constants, $f = .08 \dfrac{R^2 h}{d^2}$ and $H = h\left(1 + .08 \dfrac{R^2}{d^2}\right)$ Also $P = 15714 \dfrac{}{R}$

DIAMETER OF STEEL 1-8 INCH.

D	R	P	Values of "H" for Varying Values of "h." 1	2	3	4	5	6	7	8	9
$\frac{1}{2}''$	.188	164.0	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$\frac{9}{16}''$	.219	140.5	1.25	2.49	3.74	4.98	6.24	7.48	8.73	9.97	11.22
$\frac{5}{8}''$	.250	123.0	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
$\frac{11}{16}''$	.281	109.5	1.41	2.81	4.22	5.62	7.03	8.43	9.84	11.24	12.65
$\frac{3}{4}''$	.313	98.5	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$\frac{13}{16}''$	.344	89.5	1.61	3.21	4.82	6.42	8.03	9.63	11.24	12.84	14.45
$\frac{7}{8}''$	.375	82.0	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
$\frac{15}{16}''$	.406	75.5	1.85	3.69	5.54	7.38	9.24	11.08	12.93	14.77	16.63
1″	.438	70.0	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82
$1\frac{1}{16}''$	.469	65.5	2.12	4.24	6.36	8.48	10.60	12.72	14.84	16.96	19.08
$1\frac{1}{8}''$	.500	61.5	2.28	4.56	6.84	9.12	11.40	13.68	15.96	18.24	20.52

DIAMETER OF STEEL 3-16 INCH.

D	R	P	Values of "H" for Varying Values of "h." 1	2	3	4	5	6	7	8	9
$\frac{3}{4}''$	.281	368	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$\frac{13}{16}''$	.319	332	1.22	2.45	3.67	4.89	6.12	7.34	8.56	9.78	10.91
$\frac{7}{8}''$	.344	302	1.27	2.54	3.80	5.07	6.34	7.61	8.88	10.14	11.41
$\frac{15}{16}''$	.375	276	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.41
1″	.406	255	1.38	2.75	4.13	5.50	6.88	8.25	9.68	11.00	11.88
$1\frac{1}{16}''$	.438	237	1.44	2.87	4.31	5.74	7.18	8.61	10.05	11.48	12.92
$1\frac{1}{8}''$	.469	221	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$1\frac{3}{16}''$	.500	207	1.57	3.14	4.71	6.28	7.85	9.42	10.98	12.56	14.13
$1\frac{1}{4}''$	.531	195	1.64	3.28	4.92	5.66	8.20	9.84	11.48	13.12	14.76
$1\frac{5}{16}''$	.563	184	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
$1\frac{3}{8}''$	.594	175	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20

From Transactions of the American Society of Mechanical Engineers, 1896: MACHINERY'S Data Sheet No. 27 (Railway Edition). Explanatory note: Page 24.

HELICAL SPRING TABLES—II

DIAMETER OF STEEL 1-4 INCH.

D	R	P	Values of "H" for Varying Values of "h." 1	2	3	4	5	6	7	8	9
1″	.375	656	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$1\frac{1}{16}$″	.406	605	1.21	2.42	3.63	4.84	6.05	7.26	8.47	9.68	10.89
$1\frac{1}{8}$″	.438	562	1.25	2.49	3.74	4.98	6.23	7.47	8.72	9.96	11.21
$1\frac{3}{16}$″	.469	525	1.28	2.56	3.84	5.12	6.40	7.68	8.96	10.24	11.32
$1\frac{1}{4}$″	.500	490	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
$1\frac{5}{16}$″	.531	463	1.36	2.72	4.08	5.44	6.80	8.16	9.52	10.88	12.24
$1\frac{3}{8}$″	.563	437	1.41	2.81	4.22	5.62	7.03	8.43	9.84	11.24	12.65
$1\frac{7}{16}$″	.594	414	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05
$1\frac{1}{2}$″	.625	394	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$1\frac{5}{8}$″	.688	358	1.61	3.21	4.82	6.42	8.03	9.63	11.24	12.84	14.45
$1\frac{3}{4}$″	.750	328	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
$1\frac{7}{8}$″	.813	302	1.85	3.69	5.54	7.38	9.23	11.07	12.92	14.76	16.61
2″	.875	281	1.92	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 5-16 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
$1\frac{1}{4}$″	.469	1020	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$1\frac{3}{8}$″	.531	903	1.23	2.46	3.69	4.92	6.15	7.38	8.61	9.84	11.07
$1\frac{1}{2}$″	.594	810	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	10.61
$1\frac{5}{8}$″	.656	730	1.35	2.70	4.05	5.40	6.75	8.12	9.48	10.83	12.19
$1\frac{3}{4}$″	.719	668	1.42	2.85	4.27	5.70	7.12	8.54	9.97	11.39	12.82
$1\frac{7}{8}$″	.781	614	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
2″	.844	570	1.59	3.17	4.76	6.34	7.93	9.51	11.10	12.68	14.27
$2\frac{1}{8}$″	.906	530	1.68	3.36	5.03	6.71	8.39	10.07	11.75	13.32	15.00
$2\frac{1}{4}$″	.969	495	1.77	3.54	5.32	7.09	8.86	10.63	12.40	14.18	15.95
$2\frac{3}{8}$″	1.031	465	1.87	3.74	5.61	7.48	9.35	11.22	13.09	14.96	16.83
$2\frac{1}{2}$″	1.093	439	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82
$2\frac{5}{8}$″	1.156	415	2.11	4.22	6.33	8.44	10.55	12.66	14.77	16.88	18.99
$2\frac{3}{4}$″	1.218	394	2.22	4.44	6.66	8.88	11.10	13.32	15.54	17.76	19.98

DIAMETER OF STEEL 3-8 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
$1\frac{1}{2}$″	.563	1470	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$1\frac{5}{8}$″	.625	1330	1.22	2.44	3.57	4.89	6.11	7.35	8.55	9.78	11.06
$1\frac{3}{4}$″	.688	1210	1.27	2.54	3.80	5.07	6.34	7.61	8.88	10.14	11.41
$1\frac{7}{8}$″	.750	1100	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
2″	.813	1020	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38
$2\frac{1}{8}$″	.875	948	1.44	2.87	4.31	5.74	7.18	8.61	10.05	11.48	12.92
$2\frac{1}{4}$″	.938	883	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$2\frac{3}{8}$″	1.000	830	1.57	3.14	4.71	6.28	7.85	9.42	10.99	12.56	14.13
$2\frac{1}{2}$″	1.062	780	1.64	3.28	4.92	6.56	8.20	9.84	11.48	13.12	14.76
$2\frac{5}{8}$″	1.125	736	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
$2\frac{3}{4}$″	1.187	698	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20
$2\frac{7}{8}$″	1.250	653	1.89	3.78	5.67	7.56	9.45	11.34	13.23	15.12	17.00
3″	1.312	691	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

From Transactions of the American Society of Mechanical Engineers, 1896. MACHINERY'S Data Sheet No. 27 (Railway Edition). Explanatory note: Page 24.

HELICAL SPRING TABLES—III

DIAMETER OF STEEL 7-16 INCH.

D	R	P	Values of "H" for Varying Values of "h." 1	2	3	4	5	6	7	8	9
$1\frac{3}{4}$"	.656	2000	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$1\frac{7}{8}$"	.719	1830	1.22	2.43	3.65	4.86	6.08	7.29	8.51	9.72	10.94
2"	.781	1680	1.26	2.51	3.77	5.02	6.28	7.53	8.79	10.04	11.30
$2\frac{1}{8}$"	.844	1560	1.30	2.60	3.89	5.19	6.49	7.79	9.09	10.38	11.68
$2\frac{1}{4}$"	.906	1450	1.35	2.6	4.04	5.38	6.73	8.07	9.42	10.76	12.11
$2\frac{3}{8}$"	.969	1360	1.39	2.78	4.18	5.57	6.96	8.35	9.74	11.14	12.53
$2\frac{1}{2}$"	1.031	1270	1.44	2.89	4.33	5.77	7.22	8.66	10.10	11.54	12.99
$2\frac{5}{8}$"	1.093	1200	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$2\frac{3}{4}$"	1.156	1140	1.56	3.11	4.67	6.22	7.78	9.34	10.89	12.45	14.00
$2\frac{7}{8}$"	1.218	1080	1.62	3.24	4.85	6.47	8.09	9.71	11.33	12.94	14.56
3"	1.281	1030	1.68	3.37	5.05	6.74	8.42	10.10	11.79	13.47	15.16
$3\frac{1}{4}$"	1.406	935	1.83	3.65	5.48	7.30	9.13	10.95	12.78	14.60	16.43
$3\frac{1}{2}$"	1.531	858	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1-2 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
2"	.750	2600	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$2\frac{1}{8}$"	.813	2400	1.21	2.42	3.63	4.84	6.05	7.26	8.47	9.68	10.89
$2\frac{1}{4}$"	.875	2250	1.25	2.49	3.74	4.98	6.24	7.48	8.72	9.97	11.21
$2\frac{3}{8}$"	.938	2100	1.28	2.56	3.85	5.13	6.41	7.69	8.97	10.26	11.54
$2\frac{1}{2}$"	1.000	1970	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
$2\frac{5}{8}$"	1.062	1850	1.36	2.72	4.08	5.44	6.80	8.16	9.52	10.99	12.24
$2\frac{3}{4}$"	1.125	1750	1.41	2.81	4.22	5.62	7.03	8.43	9.84	11.24	12.65
$2\frac{7}{8}$"	1.187	1650	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05
3"	1.250	1580	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
$3\frac{1}{4}$"	1.375	1430	1.61	3.21	4.82	6.42	8.03	9.63	11.24	12.84	14.45
$3\frac{1}{2}$"	1.500	1310	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
$3\frac{3}{4}$"	1.625	1210	1.85	3.69	5.54	7.38	9.23	11.07	12.92	14.76	16.61
4 "	1.750	1130	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 9-16 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
$2\frac{1}{4}$"	.844	3300	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$2\frac{3}{8}$"	.906	3100	1.21	2.42	3.62	4.83	6.04	7.25	8.46	9.66	10.87
$2\frac{1}{2}$"	.969	2900	1.24	2.47	3.71	4.95	6.19	7.42	8.66	9.90	11.13
$2\frac{5}{8}$"	1.031	2700	1.27	2.54	3.81	5.08	6.35	7.62	8.89	10.16	11.43
$2\frac{3}{4}$"	1.093	2550	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
$2\frac{7}{8}$"	1.156	2400	1.34	2.67	4.01	5.35	6.69	8.02	9.36	10.70	12.03
3"	1.218	2300	1.37	2.75	4.12	5.50	6.87	8.24	9.62	10.99	12.37
$3\frac{1}{4}$"	1.243	2100	1.46	2.91	4.37	5.82	7.28	8.73	10.19	11.64	13.10
$3\frac{1}{2}$"	1.468	1910	1.54	3.09	4.63	6.17	7.72	9.26	10.80	12.34	13.89
$3\frac{3}{4}$"	1.593	1760	1.64	3.28	4.92	6.56	8.20	9.84	11.48	13.12	14.76
4"	1.718	1630	1.75	3.49	5.24	6.98	8.73	10.47	12.22	13.96	15.71
$4\frac{1}{4}$"	1.843	1520	1.86	3.72	5.58	7.44	9.30	11.16	13.02	14.88	16.74
$4\frac{1}{2}$"	1.968	1420	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

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HELICAL SPRING TABLES—IV

DIAMETER OF STEEL 5-8 INCH.

D	R	P	Values of "H" for Varying Values of "h."								
			1	2	3	4	5	6	7	8	9
2½″	.938	4100	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
2⅝″	1.000	3800	1.21	2.41	3.62	4.82	6.03	7.23	8.44	9.64	10.85
2¾″	1.062	3600	1.23	2.46	3.69	4.92	6.15	7.38	8.61	9.84	11.07
2⅞″	1.125	3400	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08	11.34
3″	1.187	3200	1.29	2.57	3.86	5.15	6.44	7.72	9.01	10.30	11.58
3¼″	1.312	2900	1.36	2.70	4.06	5.41	6.76	8.11	9.46	10.82	12.17
3½″	1.437	2650	1.42	2.85	4.27	5.69	7.12	8.54	9.96	11.38	12.81
3¾″	1.562	2450	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
4″	1.687	2300	1.58	3.17	4.75	6.33	7.92	9.50	11.08	12.66	14.25
4¼″	1.812	2100	1.67	3.34	5.01	6.68	8.35	10.02	11.69	13.36	15.03
4½″	1.937	1980	1.77	3.54	5.31	7.08	8.85	10.62	12.39	14.16	15.93
4¾″	2.062	1860	1.87	3.74	5.61	7.48	9.35	11.22	13.09	14.96	16.83
5″	2.187	1760	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 11-16 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
2¾″	1.031	4900	1.18	2.36	3.54	4.72	5.90	7.08	8.25	9.44	10.62
2⅞″	1.093	4700	1.20	2.40	3.61	4.81	6.01	7.21	8.41	9.62	10.82
3″	1.156	4400	1.23	2.45	3.68	4.90	6.13	7.35	8.58	9.80	11.03
3¼″	1.281	4000	1.28	2.56	3.83	5.11	6.39	7.67	8.95	10.22	11.50
3½″	1.406	3600	1.33	2.67	4.00	5.34	6.67	8.00	9.34	10.67	12.01
3¾″	1.531	3300	1.40	2.79	4.19	5.59	6.99	8.38	9.78	11.18	12.57
4″	1.656	3100	1.46	2.93	4.39	5.86	7.32	8.78	10.25	11.71	13.18
4¼″	1.781	2850	1.54	3.07	4.61	6.15	7.69	9.26	10.76	12.30	13.83
4½″	1.906	2650	1.61	3.23	4.84	6.46	8.07	9.68	11.30	12.91	14.52
4¾″	2.031	2500	1.70	3.39	5.09	6.79	8.49	10.18	11.88	13.58	15.27
5″	2.156	2350	1.79	3.57	5.36	7.14	8.93	10.71	12.50	14.28	16.07
5¼″	2.281	2250	1.88	3.76	5.64	7.52	9.40	11.28	13.15	15.04	16.92
5½″	2.406	2100	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 3-4 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
3″	1.125	5900	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
3¼″	1.250	5300	1.22	2.44	3.67	4.89	6.11	7.33	8.55	9.78	11.00
3½″	1.375	4800	1.27	2.54	3.80	5.07	6.34	7.61	8.88	10.14	11.41
3¾″	1.500	4400	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
4″	1.625	4100	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38
4¼″	1.750	3800	1.44	2.87	4.31	5.74	7.18	8.61	10.05	11.48	12.92
4½″	1.875	3500	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
4¾″	2.000	3300	1.57	3.14	4.71	6.28	7.85	9.42	10.99	12.56	14.13
5″	2.125	3100	1.64	3.28	4.92	6.56	8.20	9.84	11.48	13.12	14.76
5¼″	2.250	2950	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
5½″	2.375	2800	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20
5¾″	2.500	2700	1.89	3.78	5.67	7.56	9.45	11.34	13.23	15.12	17.00
6″	2.625	2550	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.8	17.82

From Transactions of the American Society of Mechanical Engineers, 1896. MACHINERY'S Data Sheet No. 27, (Railway Edition). Explanatory note: Page 24.

HELICAL SPRING TABLES—V

HELICAL SPRING TABLES.

The following tables are intended to give the solid load and ratio of free height to solid height for all practical varieties of helical springs. Springs designed by these tables will come solid at a fiber stress of 80,000 pounds per square inch (torsional) in the bar, equivalent to 100,000 pounds direct stress. (In practice the solid load will generally be from 5 to 15 per cent greater than the stated values, which are deduced theoretically, and are based on a maximum stress of 80,000 pounds.) The most generally preferred ratio for size is: $D = 5d$, where D is outside diameter of coil. The free height for any solid height can be found by simple addition, using the values under the nine digits. Thus free height of spring of $\frac{13}{16}''$ steel, 5″ outside diameter and 12″ solid height =

Value under 1 (point moved to right)	15.3
" " 2	3.06
Free Height	18.36

It is customary to make the static load about one-half the solid load. The following formulas were used in constructing the tables:

D = outside diameter of coil, in inches.
P = load when spring is down solid, in pounds.
S = maximum shearing fiber stress in bar, taken at 80,000 pounds.
d = diameter of steel, in inches.
R = radius of center of coil, in inches.
L = length of bar before coiling, in inches.
G = modulus of shearing elasticity taken at 12,600,000 pounds.
f = deflection of spring under load, in inches.
H = height of spring, free, in inches.
h = height of spring solid, in inches.
$\pi = 3.1416$.

Then $P = \frac{S \pi d^3}{16 R}$ $\quad f = \frac{32 P R^2 L}{G \pi d^4}$ $\quad h = \frac{L d}{2 \pi R}$ and $H = h + f$

Eliminating and reducing we have, $f = \frac{4 S \pi R^2 H}{G d^2}$, and substituting the proper constants, $f = .08 \frac{R^2 h}{d^2}$ and $H = h\left(1 + .08 \frac{R^2}{d^2}\right)$ Also $P = 15714 \frac{d^3}{R}$

DIAMETER OF STEEL 13-16 INCH.

D	R	P	Values of "H" for Varying Values of "h." 1	2	3	4	5	6	7	8	9
$3\frac{1}{4}''$	1.218	6900	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$3\frac{1}{2}''$	1.345	6300	1.22	2.44	3.65	4.87	6.09	7.31	8.53	9.74	10.96
$3\frac{3}{4}''$	1.468	5800	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08	11.34
4″	1.593	5300	1.31	2.61	3.92	5.23	6.54	7.84	9.15	10.46	11.76
$4\frac{1}{4}''$	1.718	4900	1.36	2.71	4.07	5.42	6.78	8.14	9.49	10.85	12.20
$4\frac{1}{2}''$	1.843	4600	1.41	2.82	4.23	5.64	7.05	8.46	9.87	11.28	12.69
$4\frac{3}{4}''$	1.968	4300	1.47	2.93	4.40	5.86	7.34	8.80	10.27	11.74	13.20
5″	2.093	4000	1.53	3.06	4.59	6.12	7.65	9.18	10.71	12.24	13.77
$5\frac{1}{4}''$	2.218	3800	1.59	3.18	4.78	6.37	7.96	9.55	11.14	12.74	14.33
$5\frac{1}{2}''$	2.343	3600	1.67	3.33	5.00	6.66	8.33	9.99	11.66	13.32	14.99
$5\frac{3}{4}''$	2.468	3400	1.74	3.47	5.21	6.95	8.69	10.42	12.16	13.90	15.63
6″	2.593	3300	1.81	3.62	5.43	7.24	9.05	10.86	12.67	14.48	16.29

DIAMETER OF STEEL 7-8 INCH.

$3\frac{1}{2}''$	1.312	8000	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
$3\frac{3}{4}''$	1.437	7300	1.22	2.43	3.65	4.86	6.08	7.29	8.51	9.72	10.94
4″	1.562	6700	1.25	2.51	3.76	5.02	6.27	7.52	8.78	10.03	11.29
$4\frac{1}{4}''$	1.687	6200	1.30	2.59	3.89	5.18	6.48	7.78	9.07	10.37	11.66
$4\frac{1}{2}''$	1.812	5800	1.34	2.68	4.03	5.37	6.71	8.05	9.39	10.74	12.08
$4\frac{3}{4}''$	1.937	5400	1.39	2.78	4.18	5.57	6.96	8.35	9.74	11.14	12.53
5″	2.062	5100	1.44	2.88	4.33	5.77	7.21	8.65	10.09	11.54	12.98
$5\frac{1}{4}''$	2.187	4800	1.50	3.00	4.49	5.99	7.48	8.98	10.48	11.97	13.47
$5\frac{1}{2}''$	2.312	4600	1.55	3.11	4.66	6.22	7.77	9.32	10.88	12.43	13.99
$5\frac{3}{4}''$	2.437	4300	1.62	3.23	4.85	6.46	8.08	9.69	11.31	12.92	14.54
6″	2.562	4100	1.69	3.37	5.05	6.74	8.43	10.11	11.80	13.48	15.17
$6\frac{1}{2}''$	2.812	3800	1.83	3.66	5.49	7.32	9.15	10.98	12.81	14.64	16.47

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HELICAL SPRING TABLES—VI

DIAMETER OF STEEL 15-16 INCH.

D	R	P	Values of "H" for Varying Values of "h."								
			1	2	3	4	5	6	7	8	9
3 ¾″	1.406	9200	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
4″	1.531	8500	1.21	2.43	3.64	4.86	6.07	7.28	8.50	9.71	10.93
4 ¼″	1.636	7800	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25
4 ½″	1.781	7300	1.29	2.58	3.87	5.16	6.45	7.73	9.02	10.31	11.60
4 ¾″	1.906	6800	1.33	2.66	3.99	5.32	6.65	7.98	9.31	10.64	11.97
5″	2.031	6400	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38
5 ¼″	2.156	6000	1.42	2.84	4.26	5.68	7.10	8.52	9.94	11.36	12.78
5 ½″	2.281	5700	1.47	2.95	4.42	5.89	7.37	8.84	10.31	11.78	13.26
5 ¾″	2.406	5400	1.53	3.06	4.58	6.11	7.64	9.17	10.70	12.22	13.75
6″	2.531	5100	1.58	3.16	4.74	6.32	7.90	9.48	11.06	12.64	14.22
6 ½″	2.781	4700	1.71	3.41	5.12	6.82	8.53	10.23	11.94	13.64	15.35
7″	3.031	4300	1.84	3.67	5.51	7.34	9.18	11.01	12.85	14.68	16.52
7 ½″	3.281	3900	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
4″	1.500	1.0500	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
4 ¼″	1.625	9700	1.21	2.42	3.63	4.84	6.05	7.26	8.47	9.68	10.89
4 ½″	1.750	9000	1.25	2.49	3.74	4.98	6.24	7.48	8.73	9.97	11.22
4 ¾″	1.875	8400	1.28	2.56	3.85	5.13	6.41	7.69	8.97	10.26	11.54
5″	2.000	7900	1.32	2.64	3.96	5.28	6.69	7.92	9.24	10.56	11.88
5 ¼″	2.125	7400	1.36	2.72	4.08	5.44	6.80	8.16	9.52	10.99	12.24
5 ½″	2.250	7000	1.41	2.81	4.22	5.62	7.03	8.43	9.84	11.24	12.65
5 ¾″	2.375	6600	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05
6″	2.500	6300	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
6 ½″	2.750	5700	1.61	3.21	4.82	6.42	8.03	9.63	11.24	12.84	14.45
7″	3.000	5200	1.72	3.44	5.16	6.88	8.60	10.32	12.04	13.76	15.48
7 ½″	3.250	4800	1.85	3.69	5.54	7.38	9.23	11.07	12.92	14.76	16.61
8″	3.500	4500	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 1-16 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
4 ¼″	1.593	11800	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
4 ½″	1.718	10900	1.21	2.42	3.63	4.84	6.05	7.26	8.47	9.68	10.89
4 ¾″	1.843	10200	1.24	2.48	3.72	4.96	6.20	7.44	8.68	9.92	11.16
5″	1.968	9500	1.28	2.55	3.83	5.10	6.38	7.65	8.93	10.20	11.48
5 ¼″	2.093	8900	1.31	2.62	3.93	5.24	6.55	7.86	9.17	10.48	11.79
5 ½″	2.218	8400	1.35	2.70	4.04	5.39	6.74	8.09	9.44	10.78	12.13
5 ¾″	2.343	8000	1.39	2.78	4.17	5.56	6.95	8.34	9.73	11.12	12.51
6″	2.468	7600	1.43	2.86	4.29	5.72	7.15	8.58	10.01	11.44	12.87
6 ½″	2.718	6900	1.52	3.04	4.56	6.08	7.60	9.12	10.64	12.16	13.68
7″	2.968	6300	1.63	3.25	4.88	6.50	8.13	9.75	11.38	13.00	14.63
7 ½″	3.218	5800	1.73	3.46	5.19	6.92	8.65	10.38	12.11	13.84	15.57
8″	3.468	5400	1.85	3.70	5.55	7.40	9.25	11.10	12.95	14.80	16.65
8 ½″	3.718	5000	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

From Transactions of the American Society of Mechanical Engineers, 1896. MACHINERY'S Data Sheet No. 30 (Railway Edition). Explanatory note: Page 24.

HELICAL SPRING TABLES—VII

DIAMETER OF STEEL 1 1-8 INCH.

D	R	P	Values of "H" for Varying Values of "h."								
			1	2	3	4	5	6	7	8	9
4½"	1.687	13300	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
4¾"	1.812	12400	1.21	2.42	3.62	4.83	6.04	7.25	8.46	9.66	10.87
5"	1.937	11600	1.24	2.47	3.71	4.95	6.19	7.42	8.66	9.90	11.13
5¼"	2.062	10900	1.27	2.54	3.81	5.08	6.35	7.62	8.89	10.16	11.43
5½"	2.187	10300	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
5¾"	2.312	9700	1.34	2.67	4.01	5.35	6.69	8.02	9.46	10.70	12.03
6"	2.437	9200	1.37	2.75	4.12	5.50	6.87	8.24	9.62	10.99	12.37
6½"	2.687	8300	1.46	2.91	4.37	5.82	7.28	8.73	10.19	11.64	13.10
7"	2.937	7600	1.54	3.09	4.63	6.17	7.72	9.26	10.80	12.34	13.89
7½"	3.187	7000	1.64	3.28	4.92	6.56	8.20	9.84	11.48	13.12	14.76
8"	3.437	6500	1.75	3.49	5.24	6.98	8.73	10.47	12.22	13.96	15.71
8½"	3.687	6100	1.86	3.72	5.58	7.44	9.30	11.16	13.02	14.88	16.74
9"	3.937	5700	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 13-16 INCH.

4¾"	1.781	14800	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
5"	1.906	13800	1.21	2.41	3.62	4.82	6.03	7.23	8.44	9.64	10.85
5¼"	2.031	13000	1.23	2.47	3.70	4.93	6.17	7.40	8.63	9.86	11.20
5½"	2.156	12200	1.26	2.53	3.79	5.05	6.32	7.58	8.84	10.10	11.37
5¾"	2.281	11500	1.30	2.59	3.89	5.18	6.48	7.77	9.07	10.36	11.66
6"	2.406	10900	1.33	2.66	3.98	5.31	6.64	7.97	9.30	10.62	11.95
6½"	2.656	9900	1.40	2.80	4.19	5.59	6.99	8.39	9.79	11.18	12.58
7"	2.906	9000	1.48	2.96	4.44	5.92	7.40	8.88	10.36	11.84	12.32
7½"	3.156	8300	1.56	3.13	4.69	6.25	7.82	9.38	10.94	12.50	14.07
8"	3.406	7700	1.66	3.32	4.97	6.63	8.29	9.95	11.61	12.26	14.92
8½"	3.656	7200	1.76	3.51	5.27	7.02	8.78	10.53	12.29	14.04	15.80
9"	3.906	6700	1.87	3.73	5.60	7.46	9.33	11.19	13.06	14.92	16.78
9½"	4.156	6300	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 1-4 INCH.

5"	1.875	16400	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
5¼"	2.000	15300	1.21	2.41	3.62	4.82	6.03	7.23	8.44	9.64	10.85
5½"	2.125	14500	1.23	2.46	3.69	4.92	6.15	7.38	8.61	9.84	11.07
5¾"	2.250	13700	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08	11.34
6"	2.375	12900	1.29	2.57	3.86	5.15	6.44	7.72	9.01	10.30	11.58
6½"	2.625	11700	1.36	2.70	4.06	5.41	6.70	8.11	9.46	10.82	12.17
7"	2.875	10700	1.42	2.85	4.27	5.69	7.12	8.54	9.96	11.38	12.81
7½"	3.125	9800	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
8"	3.375	9100	1.58	3.17	4.75	6.33	7.92	9.50	11.08	12.66	14.25
8½"	3.625	8500	1.67	3.34	5.01	6.68	8.35	10.02	11.69	13.36	15.03
9"	3.875	7900	1.77	3.54	5.31	7.08	8.85	10.62	12.39	14.16	15.93
9½"	4.125	7400	1.87	3.74	5.61	7.48	9.35	11.22	13.09	14.96	16.83
10"	4.375	7000	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

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HELICAL SPRING TABLES—VIII

DIAMETER OF STEEL 1 5-16 INCH.

D	R	P	Values of "H" for Varying Values of "h."								
			1	2	3	4	5	6	7	8	9
5¼″	1.968	18000	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
5½″	2.093	16900	1.20	2.41	3.61	4.81	6.02	7.22	8.42	9.62	10.83
5¾″	2.218	16000	1.23	2.46	3.68	4.91	6.14	7.37	8.60	9.82	11.05
6″	2.343	15100	1.26	2.51	3.77	5.02	6.28	7.53	8.79	10.04	11.30
6½″	2.593	13700	1.31	2.63	3.94	5.25	6.57	7.88	9.19	10.50	11.82
7″	2.843	12500	1.38	2.75	4.13	5.51	6.89	8.26	9.64	11.02	12.39
7½″	3.093	11500	1.45	2.89	4.34	5.78	7.23	8.67	10.12	11.56	13.01
8″	3.343	10600	1.52	3.04	4.56	6.08	7.60	9.12	10.64	12.16	13.68
8½″	3.593	9900	1.60	3.20	4.80	6.40	8.00	9.60	11.20	12.80	14.40
9″	3.843	9200	1.69	3.37	5.06	6.74	8.43	10.11	11.80	13.48	15.17
9½″	4.093	8600	1.78	3.56	5.34	7.12	8.90	10.68	12.48	14.24	16.02
10″	4.343	8200	1.88	3.75	5.63	7.50	9.38	11.25	13.13	15.00	16.88
10½″	4.593	7700	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 3-8 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
5½″	2.062	19800	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
5¾″	2.187	18700	1.20	2.40	3.61	4.81	6.01	7.21	8.41	9.62	10.82
6″	2.312	17600	1.23	2.45	3.68	4.90	6.13	7.35	8.58	9.80	11.03
6½″	2.562	16000	1.28	2.56	3.83	5.11	6.39	7.67	8.95	10.22	11.50
7″	2.812	14600	1.33	2.67	4.00	5.34	6.67	8.00	9.34	10.67	12.01
7½″	3.062	13400	1.40	2.79	4.19	5.59	6.99	8.38	9.78	11.18	12.57
8″	3.312	12400	1.46	2.93	4.39	5.86	7.32	8.78	10.25	11.71	13.18
8½″	3.562	11500	1.54	3.07	4.61	6.15	7.69	9.22	10.76	12.30	13.83
9″	3.812	10700	1.61	3.23	4.84	6.46	8.07	9.68	11.30	12.91	14.52
9½″	4.062	10100	1.70	3.39	5.09	6.79	8.49	10.18	11.88	13.58	15.27
10″	4.312	9500	1.79	3.57	5.36	7.14	8.98	10.71	12.50	14.28	16.07
10½″	4.562	9000	1.88	3.76	5.64	7.52	9.40	11.28	13.16	15.04	16.92
11″	4.812	8500	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

DIAMETER OF STEEL 1 7-16 INCH.

D	R	P	1	2	3	4	5	6	7	8	9
5¾″	2.156	21700	1.18	2.36	3.54	4.72	5.90	7.08	8.26	9.44	10.62
6″	2.281	20400	1.20	2.40	3.61	4.81	6.01	7.21	8.41	9.62	10.82
6½″	2.531	18500	1.25	2.50	3.74	4.99	6.24	7.49	8.74	9.98	11.23
7″	2.781	16800	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
7½″	3.031	15400	1.36	2.71	4.07	5.42	6.78	8.14	9.49	10.85	12.20
8″	3.281	14200	1.42	2.84	4.25	5.67	7.09	8.51	9.93	11.34	12.76
8½″	3.531	13200	1.48	2.96	4.45	5.93	7.41	8.89	10.37	11.86	13.34
9″	3.781	12300	1.55	3.11	4.66	6.21	7.77	9.32	10.87	12.42	13.98
9½″	4.031	11600	1.63	3.26	4.89	6.52	8.15	9.78	11.41	13.04	14.67
10″	4.281	10900	1.71	3.42	5.13	6.84	8.55	10.26	11.97	13.68	15.39
10½″	4.531	10300	1.79	3.59	5.38	7.17	8.97	10.76	12.55	14.34	16.14
11″	4.781	9800	1.89	3.78	5.67	7.56	9.45	11.34	13.23	15.12	17.00
11½″	5.031	9300	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82

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ELLIPTICAL SPRING TABLES.

The following tables are intended to give the maximum static load, and the deflection under this load, for all practical varieties of elliptic and semi-elliptic springs. The maximum static load in these tables induces a fiber strain of 80,000 pounds per square inch in the leaves and the oscillations may run this up to 100,000 pounds, which may be taken as the test load or "test load = 1¼ maximum static load." In these springs the leaves are supposed to be regularly shortened in the case of full elliptic and in the half elliptic to have one-quarter of the whole number of leaves extend to end of spring. In case all the leaves are full length, or the spring is the same section throughout, the load will not be affected, but the deflection will be,

For full elliptics use ⅔ the amounts in column named "Full."
" half " " ⅓ " " " " " "

The static load for any total width of spring can be found by simple addition, using the values found under the nine digits. Thus the load on a spring of ⅜″ thick steel 30″ long and 28″ total width =

Value under 2″ multiplied by 10	5000
" " 8″	2000
Total Load	7000

The following formulas were used in computing the tables:

P = maximum static load in pounds. S = corresponding fiber strain in leaves, taken at 80,000 pounds.
N = No. of leaves; in full elliptic half the total leaves. B = width of leaves in inches.
H = thickness of leaves in inches. L = span or length of spring in inches.
F = deflection of spring under load "P," in inches. E = modulus of elasticity, taken at 30,000,000 pounds.

$$\text{Then } P = \frac{2\,S\,N\,B\,H^2}{3\,L} \text{ and reducing, } P = \frac{53333\,N\,B\,H^2}{L}$$

$$\text{For half elliptic } F = \frac{5.5\,P\,L^3}{16\,E\,N\,B\,H^3} \text{ and reducing, } F = .000611\,\frac{L^2}{H}$$

$$\text{For full elliptic } F = \frac{12\,P\,L^3}{16\,E\,N\,B\,H^3} \text{ and reducing, } F = .00133\,\frac{L}{H}$$

THICKNESS OF STEEL, 1-16 INCH.

L	F		Values of "P" for Varying Values of "N B."								
	Half.	Full.	1	2	3	4	5	6	7	8	9
3	.09	.19	69.4	139.0	208.0	278.0	347.9	416.0	486.0	555.0	625.0
4	.16	.34	52.0	104.0	156.0	208.0	260.0	312.0	364.0	416.0	468.0
5	.25	.53	41.7	83.4	125.0	167.0	209.0	250.0	292.0	334.0	375.0
6	.35	.77	34.7	69.4	104.0	139.0	174.0	208.0	243.0	278.0	312.0
7	.48	1.04	29.8	59.6	89.4	119.0	149.0	179.0	209.0	238.0	268.0
8	.63	1.36	26.0	52.0	78.0	104.0	130.0	156.0	182.0	208.0	234.0
9	.80	1.73	23.1	46.2	69.3	92.4	116.0	139.0	162.0	185.0	208.0
10	.98	2.13	20.8	41.6	62.4	83.2	104.0	125.0	146.0	166.0	187.0
11	1.19	2.58	18.9	37.8	56.7	75.6	94.5	113.0	132.0	151.0	170.0
12	1.42	3.07	17.4	34.8	52.2	69.6	87.0	104.0	122.0	139.0	157.0
13	1.66	3.60	16.0	32.0	48.0	64.0	80.0	96.0	112.0	128.0	144.0
14	1.92	4.17	14.9	29.8	44.7	59.6	74.5	89.4	104.0	119.0	134.0
15	2.21	4.79	13.9	27.8	41.7	55.6	69.5	83.4	97.3	111.0	125.0
16	2.52	5.45	13.0	26.0	39.0	52.0	65.0	78.0	91.0	104.0	117.0
17	2.83	6.16	12.2	24.4	36.6	48.8	61.0	73.2	85.4	97.6	110.0
18	3.18	6.90	11.6	23.2	34.8	46.4	58.0	69.6	81.2	92.8	104.0

THICKNESS OF STEEL, 1-8 INCH.

L	Half.	Full.	1	2	3	4	5	6	7	8	9
5	.12	.27	167.0	334.0	501	668	835	1002	1169	1336	1503
6	.18	.39	139.0	278.0	417	556	695	834	973	1112	1251
7	.24	.52	119.0	238.0	357	476	595	714	833	952	1071
8	.31	.68	104.0	208.0	312	416	520	624	728	832	936
9	.40	.87	92.5	185.0	278	370	463	555	648	740	833
10	.49	1.06	83.3	167.0	250	333	417	500	583	666	750
11	.59	1.29	75.8	152.0	227	303	379	455	531	606	682
12	.70	1.54	69.5	139.0	209	278	348	417	487	556	626

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ELLIPTICAL SPRING TABLES—II

L	F Half.	F Full.	Values of "P" for Varying Values of "N B." 1	2	3	4	5	6	7	8	9
THICKNESS OF STEEL, 1-8 INCH. (Continued.)											
13	.83	1.80	64.2	128.0	193	257	321	385	449	514	578
14	.96	2.10	59.6	119.0	179	238	298	358	417	477	536
15	1.10	2.40	55.6	111.0	167	222	278	334	389	445	500
16	1.25	2.73	52.2	104.0	157	209	261	314	365	418	470
17	1.41	3.08	49.1	98.2	147	196	246	295	344	393	442
18	1.59	3.46	46.4	92.8	139	186	232	278	325	371	418
19	1.77	3.85	43.9	87.8	132	176	220	263	307	351	395
20	1.96	4.26	41.6	83.2	125	166	208	250	291	333	374
THICKNESS OF STEEL, 3-16 INCH.											
8	.21	.46	234.0	468.0	702.0	936.0	1170	1404	1638	1872	2106
10	.33	.71	188.0	376.0	564.0	752.0	940	1128	1316	1504	1692
12	.44	1.03	156.0	312.0	468.0	624.0	780	936	1092	1248	1404
14	.64	1.40	134.0	268.0	402.0	536.0	670	804	938	1072	1206
16	.83	1.82	117.0	234.0	351.0	468.0	585	702	819	936	1053
18	1.06	2.30	108.0	216.0	324.0	432.0	540	658	756	864	972
20	1.30	2.85	93.7	187.0	281.0	375.0	469	562	656	750	843
22	1.58	3.45	85.2	170.0	256.0	341.0	426	511	596	682	767
24	1.87	4.10	78.2	156.0	235.0	313.0	391	469	547	626	704
26	2.20	4.80	72.1	144.0	216.0	288.0	361	433	505	577	649
28	2.55	5.59	67.0	134.0	201.0	268.0	335	402	469	536	603
30	2.93	6.38	62.5	125.0	188.0	250.0	313	375	436	500	563
32	3.33	7.28	58.6	117.0	176.0	234.0	293	352	410	469	527
34	3.77	8.22	55.2	110.0	166.0	221.0	276	331	386	442	497
36	4.22	9.23	52.1	104.0	156.0	208.0	261	313	365	417	469
38	4.70	10.30	49.3	98.6	148.0	197.0	247	296	345	394	444
THICKNESS OF STEEL, 1-4 INCH.											
12	.35	.77	278	556	834	1112	1390	1668	1946	2224	2502
14	.48	1.04	238	476	714	952	1190	1428	1666	1904	2142
16	.63	1.36	209	418	627	836	1045	1254	1463	1672	1881
18	.79	1.72	185	370	555	740	925	1110	1295	1480	1665
20	.98	2.13	167	334	501	668	835	1002	1169	1336	1503
22	1.19	2.58	152	304	456	608	760	912	1064	1216	1368
24	1.41	3.07	139	278	417	556	695	834	973	1112	1251
26	1.66	3.60	128	256	384	512	640	768	896	1024	1152
28	1.92	4.18	119	238	357	476	595	714	833	952	1071
30	2.20	4.80	111	222	333	444	555	666	777	888	999
32	2.50	5.45	104	208	312	416	520	624	728	832	936
34	2.83	6.15	98	196	294	392	490	588	686	784	882
36	3.18	6.90	93	186	279	372	465	558	651	744	837
38	3.53	7.70	88	176	264	352	440	528	616	704	792
40	3.91	8.51	83	166	249	332	415	498	581	664	747
42	4.32	9.40	79	158	237	316	395	474	553	632	711

From Transactions of the American Society of Mechanical Engineers, 1896. MACHINERY'S Data Sheet No. 24 (Railway Edition). Explanatory note: Page 24.

ELLIPTICAL SPRING TABLES—III

THICKNESS OF STEEL, 5-16 INCH.

L	F		Values of "P" for Varying Values of "N B."								
	Half	Full.	1	2	3	4	5	6	7	8	9
16	.50	1.09	325	650	975	1300	1625	1950	2275	2600	2925
18	.63	1.38	290	580	870	1160	1450	1740	2030	2320	2610
20	.78	1.70	260	520	780	1040	1300	1560	1820	2080	2340
22	.95	2.07	235	470	705	940	1175	1410	1645	1880	2115
24	1.13	2.45	217	434	651	868	1085	1302	1519	1736	1953
26	1.32	2.88	200	400	600	800	1000	1200	1400	1600	1800
28	1.53	3.35	186	372	558	744	930	1116	1302	1488	1674
30	1.76	3.84	173	346	519	692	865	1038	1211	1384	1657
32	2.00	4.36	163	326	489	652	815	978	1141	1304	1467
34	2.26	4.93	153	306	459	612	765	918	1071	1224	1377
36	2.53	5.52	144	288	432	576	720	864	1008	1152	1296
38	2.82	6.15	137	274	411	548	685	822	959	1096	1233
40	3.13	6.81	130	260	390	520	650	780	910	1040	1170
42	3.45	7.51	124	248	372	496	620	744	868	992	1116
44	3.78	8.25	118	236	354	472	590	708	826	944	1062
46	4.13	9.00	113	226	339	452	565	678	791	904	1017

THICKNESS OF STEEL, 11-32 INCH.

L	Half	Full.	1	2	3	4	5	6	7	8	9
20	.71	1.55	315	630	945	1260	1575	1890	2205	2520	2835
22	.86	1.87	286	571	859	1146	1432	1719	2005	2291	2578
24	1.02	2.21	262	524	785	1048	1310	1570	1831	2091	2358
26	1.20	2.62	242	484	725	967	1209	1450	1692	1935	2176
28	1.39	3.03	224	450	675	901	1125	1350	1576	1801	2026
30	1.60	3.49	210	420	630	840	1050	1260	1470	1680	1890
32	1.82	3.98	196	393	589	786	992	1179	1376	1571	1769
34	2.05	4.47	185	369	554	739	924	1109	1295	1478	1621
36	2.30	5.01	174	349	523	698	873	1047	1223	1398	1572
38	2.54	5.59	165	331	495	662	827	993	1158	1323	1489
40	2.84	6.20	156	315	472	630	786	945	1102	1260	1417
42	3.08	6.82	149	296	448	597	748	897	1046	1196	1346
44	3.44	7.48	143	286	429	572	715	859	1002	1145	1288
46	3.75	8.17	137	274	410	547	684	821	958	1095	1232
48	4.10	8.93	131	262	393	524	655	784	917	1048	1179
50	4.45	9.65	126	252	378	504	630	756	884	1008	1134

THICKNESS OF STEEL, 3-8 INCH.

L	Half	Full.	1	2	3	4	5	6	7	8	9
20	.65	1.42	375	750	1125	1500	1875	2250	2625	3000	3375
22	.79	1.72	341	682	1023	1364	1705	2046	2387	2728	3069
24	.94	2.04	312	624	936	1248	1560	1872	2184	2496	2808
26	1.10	2.40	288	576	864	1152	1440	1728	2016	2304	2592
28	1.28	2.78	268	536	804	1072	1340	1608	1876	2144	2412
30	1.47	3.20	250	500	750	1000	1250	1500	1750	2000	2250
32	1.67	3.63	234	468	702	936	1170	1404	1638	1872	2106
34	1.88	4.10	220	440	660	880	1100	1320	1540	1760	1980

From Transactions of the American Society of Mechanical Engineers, 1896. MACHINERY'S Data Sheet No. 24 (Railway Edition). Explanatory note: Page 24.

ELLIPTICAL SPRING TABLES—IV

L	F		Values of "P" for Varying Values of "N B."								
	Half.	Full.	1	2	3	4	5	6	7	8	9
THICKNESS OF STEEL, 3-8 INCH. (Continued.)											
36	2.12	4.58	208	416	624	832	1040	1248	1456	1664	1872
38	2.35	5.12	197	394	591	788	985	1182	1379	1576	1773
40	2.60	5.68	187	375	562	750	937	1125	1312	1500	1687
42	2.87	6.26	178	356	534	712	890	1068	1246	1424	1602
44	3.15	6.86	170	341	511	682	852	1023	1193	1364	1534
46	3.45	7.50	163	326	489	652	815	978	1141	1304	1467
48	3.75	8.16	156	312	468	624	780	936	1092	1248	1404
50	4.07	8.87	150	300	450	600	750	900	1050	1200	1350
THICKNESS OF STEEL, 7-16 INCH.											
24	.81	1.76	426	852	1278	1704	2130	2556	2982	3408	3834
26	.95	2.06	393	786	1179	1572	1965	2358	2751	3144	3537
28	1.10	2.38	365	730	1095	1460	1825	2190	2555	2920	3285
30	1.26	2.74	341	682	1023	1364	1705	2046	2387	2728	3069
32	1.43	3.12	319	638	957	1276	1595	1914	2233	2552	2871
34	1.62	3.52	301	602	903	1204	1505	1806	2107	2408	2709
36	1.81	3.95	284	568	852	1136	1420	1704	1988	2272	2556
38	2.03	4.40	269	538	807	1076	1345	1614	1883	2152	2421
40	2.24	4.88	255	510	765	1020	1275	1530	1785	2040	2295
42	2.47	5.37	243	486	729	972	1215	1458	1701	1944	2187
44	2.71	5.90	232	464	696	928	1160	1392	1624	1856	2088
46	2.96	6.45	222	444	666	888	1110	1332	1554	1776	1998
48	3.22	7.00	213	426	639	852	1065	1278	1491	1704	1917
50	3.49	7.60	204	408	612	816	1020	1224	2428	1632	1836
52	3.78	8.25	197	394	591	788	985	1182	1379	1576	1773
54	4.08	8.90	189	378	567	756	945	1334	1323	1512	1701
THICKNESS OF STEEL, 1-2 INCH.											
30	1.10	2.40	444	888	1332	1776	2220	2664	3108	3552	3996
32	1.25	2.72	416	832	1248	1664	2080	2496	2912	3328	3744
34	1.41	3.07	392	784	1176	1568	1960	2352	2744	3136	3528
36	1.58	3.45	372	744	1116	1488	1860	2232	2604	2976	3348
38	1.76	3.84	350	700	1050	1400	1750	2100	2450	2800	3150
40	1.95	4.25	333	666	999	1332	1665	1998	2331	2664	2997
42	2.16	4.68	317	634	951	1268	1585	1902	2219	2536	2853
44	2.37	5.15	303	606	909	1212	1515	1818	2121	2424	2727
46	2.58	5.62	290	580	870	1160	1450	1740	2030	2320	2610
48	2.82	6.13	277	554	831	1108	1385	1662	1939	2216	2493
50	3.06	6.65	266	532	798	1064	1330	1596	1862	2128	2394
52	3.30	7.19	256	512	768	1024	1280	1336	1792	2048	2304
54	3.57	7.75	247	494	741	988	1235	1482	1729	1976	2223
56	3.83	8.35	238	476	714	952	1190	1428	1666	1904	2142
58	4.12	8.95	230	460	690	920	1150	1380	1610	1840	2070
60	4.40	9.58	222	444	666	888	1110	1332	1554	1776	1998

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The designing of springs, when using these tables, becomes simply a matter of multiplying the load the spring is to carry by a proper factor of safety, and then selecting a resultant pressure in the tables; from this, the diameter of the wire and the deflection can be found readily. Dividing the deflection given in the table by the same factor of safety as was used for the load, will give the actual deflection per coil, and adding this value to the diameter of the wire will give the pitch for a compression spring. The number of coils will depend upon the amount of movement the spring requires, and knowing this, we divide the length of movement by the deflection per coil, which gives the number of effective coils, and then add 1½ coils for the ends. As a rule, the mean diameter of a helical spring should be from 8 to 10 times the diameter of the wire.

Helical Spring Tables

On pages 12 to 19 inclusive are given another set of helical spring tables arranged in a somewhat different manner from those already referred to. These tables are based upon a maximum stress of 80,000 pounds per square inch. When the outside diameter of the spring, in inches, and the diameter of wire are known, the values found from the tables are the load in pounds when the spring is down solid, and the free height of the spring in inches.

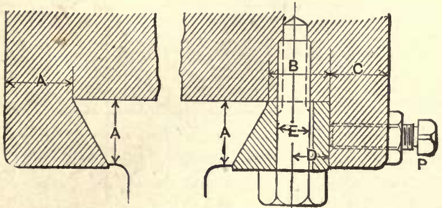
As an example, assume that the free height of a spring of 6 inches solid height, made of 1/8-inch steel and having 1 inch outside diameter is required. In the table headed "Diameter of Steel 1/8-inch," locate the outside diameter $D = 1$ inch, and opposite 1 inch and in the column headed 6 (solid height of spring), we find that the free height equals 11.88 inches. In the third column from the left we find that the maximum load the spring can carry is 70 pounds. [MACHINERY, January, 1910, Railway Edition, The Design of Heavy Helical Springs for Railroad Cars; MACHINERY's Reference Series No. 58, Helical and Elliptic Springs, Chapter II, The Design of Heavy Helical Springs.]

Elliptical Spring Tables

On pages 20 to 23 is given a set of tables for the calculation of elliptical springs. These tables give the maximum static load and the deflection under this load for a fiber stress of 80,000 pounds per square inch; L is the span or length of the spring in inches, F is the deflection of the spring under the load P in inches, given both for the semi- and full-elliptical springs; the values in the columns headed 1, 2, 3, etc., are the maximum static loads in pounds for various values of the product of the number of leaves in a semi-elliptical spring (or one-half the number of total leaves in a full-elliptical spring) multiplied by the width of the leaves in inches.

As an example assume that it is required to find the load to which a semi-elliptical spring made of six 1/16-inch leaves of a length of 10 inches and a width of ½ inch should be subjected. First multiply the number of leaves by the width of the leaves in inches: $6 \times 1/2 = 3$. Now locate in the table headed "Thickness of Steel, 1/16 inch," the length of the spring in the left-hand column. Then opposite the length of the spring, in this case 10 inches, and in the column headed 3, we find that the maximum static load to which this semi-elliptical spring may be subjected, is 62.4 pounds. In the second column from the left we find that the maximum deflection of the spring under load P equals 0.98 inch. [MACHINERY, January, 1910, The Design of Automobile Springs; MACHINERY's Reference Series No. 58, Helical and Elliptic Springs, Chapter III, The Design of Elliptic Springs.]

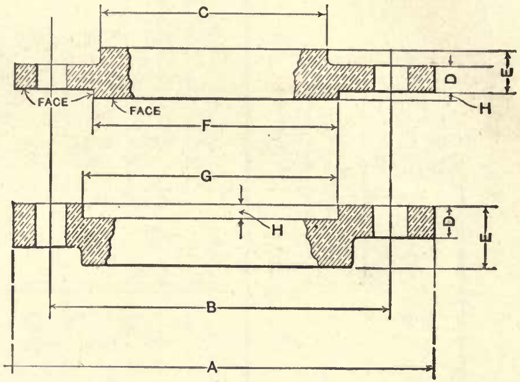
MACHINE V-STRIPS.



Computed by A. E. Ingham, Altrincham, Eng.

A	B	C	D	E	P
1/4	5/16	1/4	3/16	3/16	1/8
3/8	7/16	5/16	9/32	1/4	3/16
1/2	9/16	3/8	3/8	5/16	1/4
5/8	5/8	7/16	7/16	5/16	1/4
3/4	3/4	9/16	1/2	3/8	5/16
7/8	7/8	11/16	9/16	1/2	5/16
1	1	3/4	5/8	1/2	3/8
1 1/4	1 1/8	1	3/4	5/8	3/8
1 1/2	1 3/8	1 1/8	7/8	3/4	1/2
1 3/4	1 1/2	1 1/4	1	3/4	5/8
2	1 3/4	1 1/2	1 1/8	7/8	3/4
2 1/4	2	1 5/8	1 3/8	7/8	3/4
2 1/2	2 1/8	1 3/4	1 1/2	1	3/4
3	2 1/2	2	1 7/8	1	7/8

STANDARD MALE AND FEMALE BRASS FLANGES FOR 250 POUNDS PRESSURE.

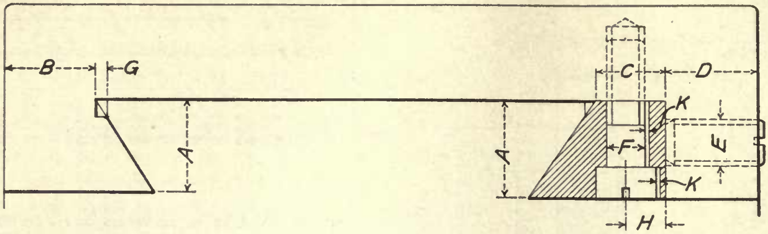


Computed by A. de Bretteville, San Francisco, Cal.

Size of Pipe.	A	B	C	D	E	F	G	H	No. of Bolts.	Size of Bolts.
1	4	2 7/8	1 3/4	1/2	9/16	2	2 1/32	1/8	4	1/2
1 1/4	4 1/2	3 1/4	2 1/8	1/2	5/8	2 1/4	2 9/32	1/8	4	1/2
1 1/2	5	3 5/8	2 1/4	1/2	3/4	2 5/8	2 21/32	1/8	4	5/8
2	6	4 1/2	2 7/8	1/2	7/8	3 1/4	3 9/32	1/8	5	5/8
2 1/2	7	5 1/2	3 5/8	9/16	1	4	4 1/32	1/8	6	5/8
3	7 1/2	6	4 1/4	5/8	1 1/8	4 1/2	4 17/32	1/8	6	5/8
3 1/2	8 1/2	6 3/4	4 7/8	11/16	1 1/8	5 1/4	5 9/32	1/8	6	3/4
4	9	7 1/4	5 3/8	11/16	1 1/4	5 3/4	5 25/32	1/8	6	3/4
4 1/2	9 1/2	7 3/4	6	11/16	1 1/4	6 1/4	6 9/32	1/8	8	3/4
5	10	8 1/4	6 3/8	3/4	1 3/8	6 3/4	6 25/32	1/8	8	3/4
6	11	9 1/4	7 1/2	3/4	1 3/8	7 3/4	7 25/32	1/8	8	3/4
7	12 1/2	10 3/4	9	13/16	1 3/8	9	9 1/32	1/8	8	3/4
8	13 1/2	11 3/4	10	7/8	1 5/8	10	10 1/32	1/8	8	3/4
9	15	13 1/4	11 1/4	15/16	1 5/8	11 1/4	11 9/32	1/8	12	3/4
10	16	14 1/4	12 1/4	15/16	1 7/8	12 1/4	12 9/32	1/8	12	3/4
12	19	17	14 3/4	1 1/16	1 7/8	14 1/2	14 17/32	1/8	12	3/4

DIMENSIONS OF MACHINE SLIDES—I

Bedded Strips.

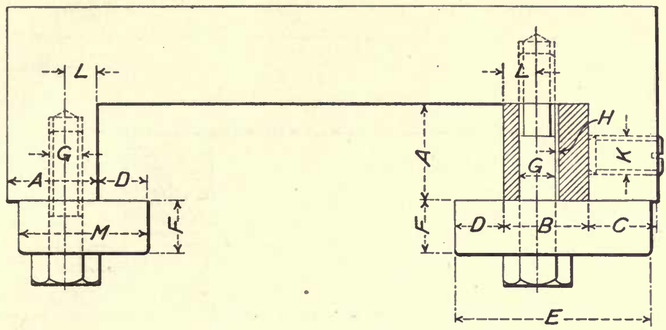


A	B	C	D	E	F	G	H	K
1/4	5/16	3/8	1/4	1/8	3/16	1/64	1/4	1/32
3/8	7/16	1/2	5/16	3/16	1/4	3/128	5/16	1/32
1/2	5/8	5/8	3/8	1/4	5/16	1/32	3/8	1/32
5/8	3/4	3/4	1/2	5/16	3/8	1/32	1/2	1/32
3/4	7/8	7/8	5/8	5/16	3/8	3/64	5/8	1/32
7/8	1	1	3/4	3/8	1/2	3/64	11/16	1/16
1	1 1/4	1 1/8	7/8	3/8	1/2	1/16	13/16	1/16
1 1/4	1 3/8	1 1/4	1	1/2	5/8	5/64	7/8	1/16
1 1/2	1 5/8	1 3/8	1 1/4	5/8	5/8	3/32	1	1/16
1 3/4	1 7/8	1 1/2	1 3/8	5/8	3/4	7/64	1	1/16
2	2 1/4	1 3/4	1 1/2	3/4	7/8	1/8	1 1/4	1/16
2 1/4	2 1/2	2	1 3/4	3/4	1	1/8	1 3/8	1/8
2 1/2	2 3/4	2 1/4	2	7/8	1	5/32	1 1/2	1/8
2 3/4	3	2 1/2	2 1/4	7/8	1 1/8	5/32	1 3/4	1/8
3	3 1/4	2 3/4	2 1/2	1	1 1/8	3/16	2	1/8

Contributed by A. W. Boase, MACHINERY'S Data Sheet No. 103. Explanatory note: Page 40.

DIMENSIONS OF MACHINE SLIDES—II

Square Strips.



A	B	C	D	E	F	G	H	K	L	M
1/4	3/8	1/4	1/4	27/32	3/16	3/16	1/32	1/8	5/32	15/32
3/8	1/2	5/16	5/16	1 3/32	1/4	1/4	1/32	3/16	7/32	21/32
1/2	5/8	3/8	3/8	1 5/16	5/16	5/16	1/32	1/4	9/32	13/16
5/8	3/4	1/2	1/2	1 11/16	3/8	3/8	1/32	5/16	5/16	1 1/16
3/4	7/8	5/8	5/8	2 1/16	1/2	3/8	1/32	5/16	5/16	1 5/16
7/8	1	3/4	3/4	2 7/16	5/8	1/2	1/16	3/8	3/8	1 9/16
1	1 1/8	7/8	7/8	2 3/4	3/4	1/2	1/16	3/8	7/16	1 3/4
1 1/4	1 1/4	1	1	3 1/8	7/8	5/8	1/16	1/2	7/16	2 1/8
1 1/2	1 3/8	1 1/8	1 1/8	3 1/2	1	5/8	1/16	1/2	1/2	2 1/2
1 3/4	1 1/2	1 1/4	1 1/4	3 7/8	1 1/8	3/4	1/16	5/8	9/16	2 7/8
2	1 3/4	1 1/2	1 1/2	4 5/8	1 1/4	7/8	1/16	3/4	5/8	3 3/8
2 1/4	2	1 5/8	1 5/8	5	1 3/8	7/8	1/8	3/4	11/16	3 5/8
2 1/2	2 1/4	1 3/4	1 3/4	5 1/2	1 1/2	1	1/8	7/8	3/4	4
2 3/4	2 1/2	1 7/8	1 7/8	6	1 5/8	1	1/8	7/8	13/16	4 3/8
3	2 3/4	2	2	6 1/2	1 3/4	1 1/8	1/8	1	7/8	4 3/4
3 1/2	3 1/8	2 1/4	2 1/4	7 1/4	1 7/8	1 1/4	1/8	1 1/8	1	5 3/8
4	3 1/2	2 1/2	2 1/2	8	2	1 1/2	1/8	1 1/4	1 1/8	6

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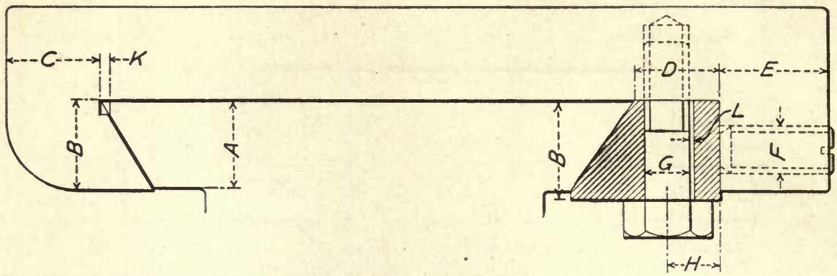
DIMENSIONS OF MACHINE SLIDES—III

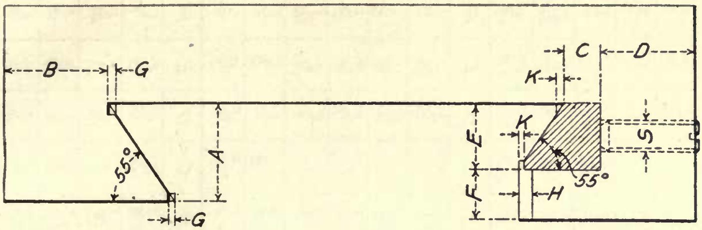
Overhung Strips



A	B	C	D	E	F	G	H	K	L
1/4	9/32	5/16	3/8	1/4	1/8	3/16	1/4	1/64	1/32
3/8	13/32	7/16	1/2	5/16	3/16	1/4	5/16	3/128	1/32
1/2	9/16	5/8	5/8	3/8	1/4	5/16	3/8	1/32	1/32
5/8	11/16	3/4	3/4	1/2	5/16	3/8	1/2	1/32	1/32
3/4	13/16	3/4	3/4	5/8	5/16	1/2	5/8	3/64	1/32
7/8	15/16	1	1	3/4	3/8	1/2	11/16	3/64	1/16
1	1 1/8	1 1/4	1	7/8	3/8	1/2	11/16	1/16	1/16
1 1/4	1 3/8	1 1/2	1 1/8	1	1/2	5/8	3/4	5/64	1/16
1 1/2	1 5/8	1 3/4	1 1/4	1 1/8	1/2	5/8	7/8	3/32	1/16
1 3/4	1 7/8	2	1 1/2	1 1/4	5/8	3/4	1	3/32	1/16
2	2 3/16	2 1/4	1 3/4	1 1/2	3/4	7/8	1 1/4	1/8	1/16
2 1/4	2 1/2	2 1/2	2	1 5/8	3/4	7/8	1 1/2	1/8	1/8
2 1/2	2 3/4	2 3/4	2 1/4	1 3/4	7/8	1	1 7/8	5/32	1/8
2 3/4	3	3	2 1/2	1 7/8	7/8	1	1 7/8	5/32	1/8
3	3 1/4	3 1/4	2 3/4	2	1	1 1/8	2	3/16	1/8

DIMENSIONS OF MACHINE SLIDES—IV

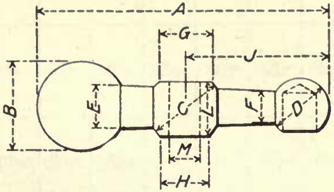
Special Strips.



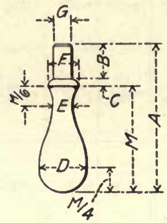
A	B	C	D	E	F	G	H	K	S
1	$1\frac{1}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{3}{64}$	$\frac{3}{8}$
$1\frac{1}{8}$	$1\frac{3}{16}$	$\frac{9}{16}$	$\frac{11}{16}$	$\frac{7}{8}$	$\frac{9}{16}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{3}{64}$	$\frac{3}{8}$
$1\frac{1}{4}$	$1\frac{5}{16}$	$\frac{5}{8}$	$\frac{13}{16}$	$\frac{15}{16}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{3}{64}$	$\frac{3}{8}$
$1\frac{3}{8}$	$1\frac{7}{16}$	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{11}{16}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{64}$	$\frac{1}{2}$
$1\frac{1}{2}$	$1\frac{9}{16}$	$\frac{3}{4}$	$\frac{15}{16}$	$1\frac{1}{8}$	$\frac{3}{4}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{64}$	$\frac{1}{2}$
$1\frac{5}{8}$	$1\frac{11}{16}$	$\frac{13}{16}$	1	$1\frac{1}{4}$	$\frac{13}{16}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{64}$	$\frac{1}{2}$
$1\frac{3}{4}$	$1\frac{13}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{5}{16}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{32}$	$\frac{5}{8}$
$1\frac{7}{8}$	$1\frac{15}{16}$	$\frac{15}{16}$	$1\frac{3}{16}$	$1\frac{7}{16}$	$\frac{15}{16}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{32}$	$\frac{5}{8}$
2	$2\frac{1}{8}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	1	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{32}$	$\frac{3}{4}$
$2\frac{1}{4}$	$2\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{11}{16}$	$1\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{32}$	$\frac{3}{4}$
$2\frac{1}{2}$	$2\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{9}{16}$	$1\frac{7}{8}$	$1\frac{1}{4}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{7}{8}$
$2\frac{3}{4}$	$2\frac{7}{8}$	$1\frac{3}{8}$	$1\frac{3}{4}$	$2\frac{1}{16}$	$1\frac{3}{8}$	$\frac{3}{16}$	$\frac{9}{16}$	$\frac{1}{8}$	$\frac{7}{8}$
3	$3\frac{3}{16}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{3}{16}$	$\frac{9}{16}$	$\frac{1}{8}$	1
$3\frac{1}{4}$	$3\frac{7}{16}$	$1\frac{5}{8}$	2	$2\frac{7}{16}$	$1\frac{5}{8}$	$\frac{3}{16}$	$\frac{5}{8}$	$\frac{1}{8}$	$1\frac{1}{8}$
$3\frac{1}{2}$	$3\frac{11}{16}$	$1\frac{3}{4}$	$2\frac{3}{16}$	$2\frac{5}{8}$	$1\frac{3}{4}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{16}$	$1\frac{1}{4}$
$3\frac{3}{4}$	$3\frac{15}{16}$	$1\frac{7}{8}$	$2\frac{3}{8}$	$2\frac{13}{16}$	$1\frac{7}{8}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{16}$	$1\frac{1}{4}$
4	$4\frac{1}{4}$	2	$2\frac{1}{2}$	3	2	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{16}$	$1\frac{1}{2}$

Contributed by A. W. Boase, MACHINERY'S Data Sheet No. 103. Explanatory note: Page 40.

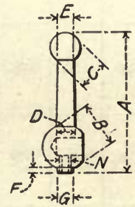
BALL-CRANK MACHINE HANDLES AND LEVERS



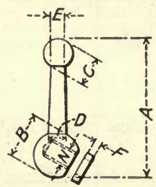
No.	A	B	C	D	E	F	G	H	J	L	M
1	3	7/8	11/16	9/16	3/8	5/16	1/2	7/16	1 1/2	1/2	1/4
2	3 1/4	15/16	25/32	5/8	7/16	5/16	9/16	1/2	1 5/8	9/16	5/16
3	3 1/2	1 1/16	29/32	3/4	15/32	11/32	5/8	9/16	1 3/4	11/16	3/8
4	4	1 1/4	1	3/4	17/32	13/32	3/4	11/16	2	3/4	7/16
5	4 1/2	1 5/16	1 3/32	27/32	19/32	7/16	3/4	11/16	2 1/4	13/16	1/2
6	5	1 1/2	1 5/16	1	3/4	1/2	7/8	13/16	2 1/2	1	1/2
7	5 1/2	1 1/2	1 5/16	1	3/4	1/2	7/8	13/16	2 3/4	1	1/2
8	6	1 5/8	1 3/8	1	3/4	1/2	1	15/16	3	1	5/8
9	6 1/2	1 5/8	1 3/8	1	3/4	1/2	1	15/16	3 1/4	1	5/8
10	7	1 3/4	1 7/16	1	3/4	9/16	1	15/16	3 1/2	1 1/16	5/8
11	7 1/2	1 3/4	1 1/2	1	3/4	9/16	1	15/16	3 3/4	1 3/32	5/8
12	8	1 3/4	1 1/2	1 1/16	3/4	9/16	1	15/16	4	1 1/8	5/8
13	8 1/2	1 3/4	1 9/16	1 1/8	3/4	5/8	1 1/8	1 1/16	4 1/4	1 3/32	3/4
14	9	1 3/4	1 5/8	1 3/16	3/4	5/8	1 1/8	1 1/16	4 1/2	1 1/4	3/4



No.	A	B	C	D	E	F	G
0	2 1/4	1/2	3/32	11/16	11/32	1/2	5/16
1	2 3/4	5/8	1/8	13/16	13/32	5/8	3/8
2	3 1/8	3/4	1/8	1	1/2	5/8	3/8
3	3 1/2	3/4	5/32	1 1/16	17/32	3/4	7/16
4	4	7/8	3/16	1 1/8	9/16	27/32	7/16
5	4 3/8	7/8	7/32	1 3/16	19/32	15/16	15/32



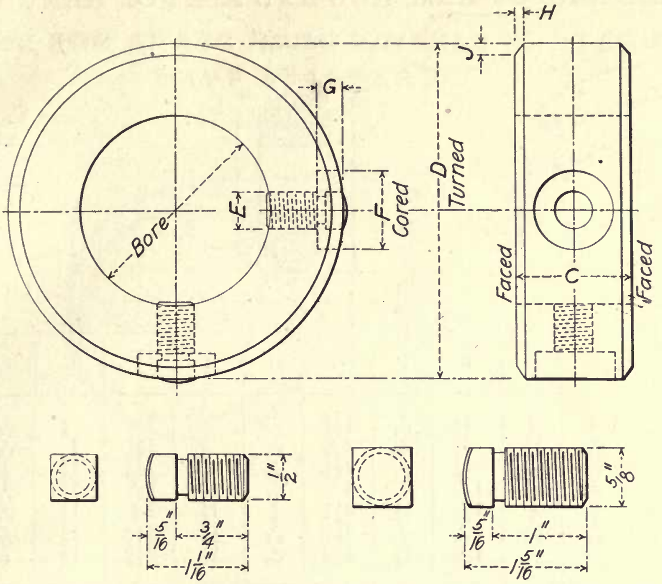
No.	A	B	C	D	E	F	G	N
2	4 1/2	1 3/8	7/8	5/8	7/16	1/8	5/8	5/16
4	5 1/2	1 1/2	1	11/16	1/2	1/8	5/8	3/8
6	6 1/2	1 3/4	1	3/4	9/16	3/16	5/8	3/8
8	7 1/2	1 3/4	1	3/4	9/16	3/16	5/8	7/16
10	8 1/2	1 3/4	1 1/8	3/4	5/8	1/4	11/16	7/16
11	9	1 3/4	1 3/16	13/16	5/8	1/4	11/16	7/16



No.	A	B	C	D	E	F	N
12	4 1/2	1 3/8	7/8	5/8	7/16	1/4	1/2
14	5 1/2	1 1/2	1	11/16	1/2	1/4	1/2
16	6 1/2	1 3/4	1	3/4	9/16	1/4	1/2
18	7 1/2	1 3/4	1	3/4	9/16	1/4	5/8
20	8 1/2	1 3/4	1 1/8	3/4	5/8	1/4	5/8
21	9	1 3/4	1 3/16	13/16	5/8	1/4	5/8

Contributed by J. C. Spence, MACHINERY'S Data Sheet No. 96. Explanatory note: Page 40.

SAFETY SET-SCREW COLLAR

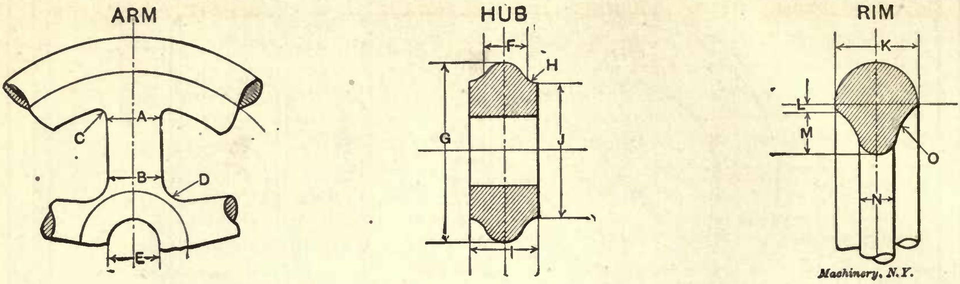


Bore	C	D	E	F	G	H	J
$1\frac{7}{16}$	$1\frac{5}{8}$	$3\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
$1\frac{11}{16}$	$1\frac{5}{8}$	$3\frac{3}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
$1\frac{15}{16}$	$1\frac{5}{8}$	4	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
$2\frac{3}{16}$	$1\frac{5}{8}$	$4\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$
$2\frac{7}{16}$	$1\frac{5}{8}$	$4\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$
$2\frac{11}{16}$	$1\frac{5}{8}$	$4\frac{3}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$
$2\frac{15}{16}$	$1\frac{5}{8}$	5	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$
$3\frac{3}{16}$	$1\frac{7}{8}$	$5\frac{7}{8}$	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{3}{16}$
$3\frac{7}{16}$	$1\frac{7}{8}$	6	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{3}{16}$
$3\frac{15}{16}$	$1\frac{7}{8}$	$6\frac{5}{8}$	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{3}{16}$
$4\frac{7}{16}$	$1\frac{7}{8}$	$7\frac{1}{8}$	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{4}$
$4\frac{15}{16}$	$1\frac{7}{8}$	$7\frac{5}{8}$	$\frac{5}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{4}$
$5\frac{7}{16}$	2	$8\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{1}{4}$

Explanatory note: Page 40.

HAND WHEELS AND ROPE PULLEYS

PROPORTIONS OF ARM, HUB AND RIM FOR HAND WHEELS.

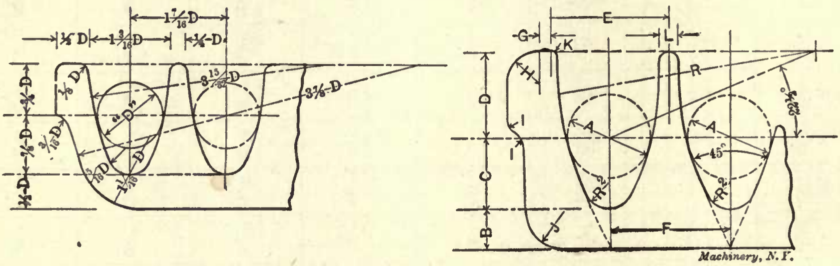


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
6	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{16}$	$1\frac{29}{32}$	$\frac{1}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{7}{8}$	$\frac{1}{16}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{1}{2}$
8	$\frac{13}{16}$	1	$\frac{5}{32}$	$\frac{13}{32}$	$\frac{13}{16}$	$\frac{1}{2}$	$2\frac{9}{32}$	$\frac{5}{64}$	$\frac{7}{8}$	$1\frac{23}{32}$	1	$\frac{3}{32}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{9}{16}$
10	$\frac{15}{16}$	$1\frac{3}{16}$	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{15}{16}$	$\frac{9}{16}$	$2\frac{41}{64}$	$\frac{3}{32}$	1	$1\frac{15}{16}$	$1\frac{1}{8}$	$\frac{1}{8}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{5}{8}$
12	$1\frac{1}{16}$	$1\frac{3}{8}$	$\frac{7}{32}$	$\frac{15}{32}$	$1\frac{1}{16}$	$\frac{5}{8}$	3	$\frac{7}{64}$	$1\frac{1}{8}$	$2\frac{5}{32}$	$1\frac{1}{4}$	$\frac{5}{32}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{11}{16}$
14	$1\frac{3}{16}$	$1\frac{9}{16}$	$\frac{1}{4}$	$\frac{1}{2}$	$1\frac{3}{16}$	$\frac{11}{16}$	$3\frac{11}{32}$	$\frac{1}{8}$	$1\frac{1}{4}$	$2\frac{3}{8}$	$1\frac{3}{8}$	$\frac{6}{32}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$
16	$1\frac{5}{16}$	$1\frac{3}{4}$	$\frac{9}{32}$	$\frac{17}{32}$	$1\frac{5}{16}$	$\frac{3}{4}$	$3\frac{23}{32}$	$\frac{9}{64}$	$1\frac{3}{8}$	$2\frac{19}{32}$	$1\frac{1}{2}$	$\frac{7}{32}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{13}{16}$
18	$1\frac{7}{16}$	$1\frac{15}{16}$	$\frac{5}{16}$	$\frac{9}{16}$	$1\frac{7}{16}$	$\frac{13}{16}$	$4\frac{3}{32}$	$\frac{5}{32}$	$1\frac{1}{2}$	$2\frac{13}{16}$	$1\frac{5}{8}$	$\frac{1}{4}$	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{7}{8}$

Contributed by M. J. Hallam, Waterbury, Conn.

PROPORTIONS OF GROOVES FOR MANILA ROPE.

(Jeffrey Mfg. Co.)



Contributed by S. J. Nelson, Chicago, Ill.

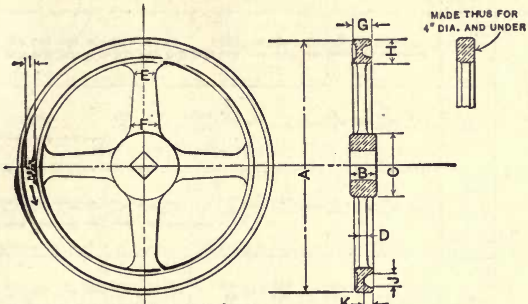
Rope Diam. A	B	C	D	E	F	G	H	I	J	K	L
$\frac{3}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{11}{16}$	$1\frac{3}{8}$	$1\frac{3}{8}$	$\frac{1}{16}$	$\frac{5}{16}$	$\frac{3}{16}$	$\frac{11}{16}$	$\frac{1}{8}$	$\frac{1}{4}$
$\frac{7}{8}$	$\frac{3}{8}$	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{13}{16}$	$\frac{1}{8}$	$\frac{1}{4}$
1	$\frac{3}{8}$	$\frac{7}{8}$	$1\frac{3}{16}$	$1\frac{7}{8}$	$1\frac{7}{8}$	$\frac{1}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{16}$	$\frac{3}{8}$
$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{15}{16}$	$1\frac{1}{4}$	2	2	$\frac{3}{32}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{3}{8}$
$1\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{3}{8}$
$1\frac{3}{8}$	$\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{3}{8}$
$1\frac{1}{2}$	$\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{9}{16}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{3}{8}$
$1\frac{3}{4}$	$\frac{7}{8}$	$1\frac{9}{16}$	$1\frac{11}{16}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{3}{8}$
2	$\frac{7}{8}$	$1\frac{9}{16}$	$1\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{5}{8}$	$\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{8}$

NOTE.—Radius "R²" is determined by trial and is to be tangent to intersecting lines.

The long radius "R" is determined by drawing a line through center of rope, at an angle of 22½° (with horizontal center line), producing it until it intersects a line drawn on tops of dividing ribs.

DIMENSIONS OF HAND WHEELS

DIMENSIONS FOR BRASS HAND WHEELS (UNITED STATES NAVY STANDARD).

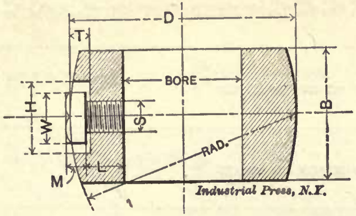


CAST LETTERING ON WHEELS ABOVE 4" DIAM.
CUT LETTERING ON WHEELS 4" DIAM. AND UNDER

Dia. of Wheel.	HUB.		ARMS.				RIM.				Size of Letter.
	Thick.	Dia.	Thich.	Width.		Number	Width.	Depth.	Groove.		
A	B	C	D	E	F		G	H	Width. J	Depth. K	I
1 1/2"	5/16"	9/16"	1/8"	3/16"	1/4"	4	1/4"	1/4"	0	0	5/32"
2	3/8	5/8	1/8	1/4	5/16	4	1/4	11/32	0	0	5/32
2 1/2	7/16	3/4	1/8	5/16	3/8	4	1/4	13/32	0	0	5/32
3	7/16	7/8	1/8	5/16	7/16	4	1/4	7/16	0	0	5/32
3 1/2	1/2	1 1/8	3/16	3/8	1/2	4	1/4	7/16	0	0	1/4
4	1/2	1 3/16	3/16	3/8	9/16	4	1/4	1/2	0	0	1/4
4 1/2	9/16	1 1/4	3/16	7/16	5/8	4	3/8	5/8	5/16"	3/32"	1/4
5	5/8	1 3/8	3/16	7/16	5/8	4	3/8	5/8	5/16	1/8	1/4
6	11/16	1 5/8	1/4	1/2	11/16	4	13/32	5/8	5/16	3/16	1/4
7	3/4	1 3/4	1/4	9/16	3/4	4	1/2	11/16	3/8	9/32	1/4
8	3/8	1 7/8	5/16	5/8	13/16	4	17/32	11/16	11/32	5/16	1/4
9	15/16	2	5/16	5/8	7/8	4	9/16	3/4	13/32	11/32	1/4
10	1	2	3/8	11/16	15/16	5	19/32	13/16	7/16	11/32	5/16
11	1 1/16	2 1/8	3/8	3/4	1	5	21/32	7/8	1/2	13/32	5/16
12	1 1/8	2 1/4	3/8	3/4	1 1/16	5	11/16	15/16	1/2	13/32	3/8
14	1 5/16	2 1/2	7/16	7/8	1 3/16	5	27/32	1 1/8	5/8	17/32	3/8
16	1 7/16	2 13/16	1/2	15/16	1 5/16	6	15/16	1 1/4	11/16	5/8	3/8
18	1 5/8	3 1/16	9/16	1 1/16	1 7/16	6	1 1/16	1 3/8	3/4	5/8	3/8
21	1 7/8	3 1/2	5/8	1 3/16	1 5/8	6	1 3/16	1 5/8	31/32	3/4	1/2
24	2 1/16	3 7/8	11/16	1 5/16	1 3/4	6	1 5/16	1 13/16	1 1/16	7/8	1/2

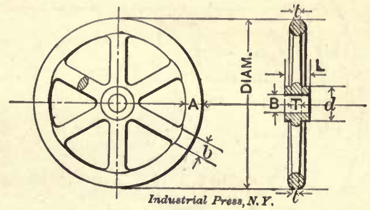
Contributed by F. W. Armes, MACHINERY'S Data Sheet No. 28. Explanatory note: Page 40.

PROPORTIONS FOR COLLARS.



Bore.	B	D	H	L	M	S	T	W
1 7/16	1 5/8	2 3/4	7/8	17/32	3/16	3/8	1/4	5/8
1 9/16	1 3/4	3	7/8	19/32	3/16	3/8	1/4	5/8
1 11/16	1 7/8	3 1/4	1	19/32	1/4	1/2	5/16	3/4
1 15/16	2	3 5/8	1 1/4	19/32	5/16	5/8	3/8	15/16
2 3/16	2 1/8	4	1 1/4	21/32	5/16	5/8	3/8	15/16
2 7/16	2 1/4	4 3/8	1 1/4	23/32	5/16	5/8	3/8	15/16
2 11/16	2 1/2	4 3/4	1 1/2	23/32	3/8	3/4	7/16	1 1/8
2 15/16	2 5/8	5 1/4	1 1/2	27/32	3/8	3/4	7/16	1 1/8
3 3/16	2 3/4	5 3/4	1 1/2	1	3/8	3/4	7/16	1 1/8
3 7/16	2 7/8	6 1/4	1 3/4	1 1/16	7/16	7/8	1/2	1 5/16
3 11/16	3	6 3/4	1 3/4	1 3/16	1/16	7/8	1/2	1 5/16
3 15/16	3 1/8	7 1/4	1 3/4	1 5/16	7/16	7/8	1/2	1 5/16
4 3/16	3 1/4	7 3/4	2	1 7/16	1/2	1	9/16	1 1/2
4 7/16	3 3/8	8 1/4	2	1 1/2	1/2	1	9/16	1 1/2
4 15/16	3 5/8	8 3/4	2 1/4	1 1/2	9/16	1 1/8	9/16	1 5/8
5 7/16	3 7/8	9 1/4	2 1/4	1 1/2	9/16	1 1/8	9/16	1 5/8
5 15/16	4 1/8	9 3/4	2 1/4	1 1/2	9/16	1 1/8	5/8	1 5/8
6 7/16	4 3/8	10 1/4	2 1/4	1 1/2	9/16	1 1/8	5/8	1 5/8
6 15/16	4 5/8	10 3/4	2 1/2	1 7/16	5/8	1 1/4	11/16	1 3/4
7 7/16	4 7/8	11 1/4	2 1/2	1 7/16	5/8	1 1/4	11/16	1 3/4
7 15/16	5 1/8	11 3/4	2 1/2	1 7/16	5/8	1 1/4	11/16	1 3/4
8 7/16	5 3/8	12 1/4	2 1/2	1 7/16	5/8	1 1/4	11/16	1 3/4
8 15/16	5 5/8	12 3/4	2 1/2	1 7/16	5/8	1 1/4	11/16	1 3/4
9 7/16	5 7/8	13 1/4	3	1 5/16	3/4	1 1/2	13/16	2
9 15/16	6 1/8	13 3/4	3	1 5/16	3/4	1 1/2	13/16	2

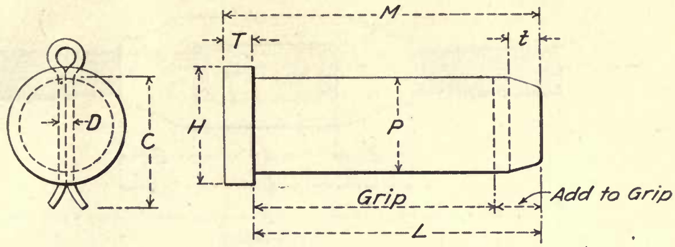
PROPORTIONS FOR HAND WHEELS.



Diam.	A	B	b	d	T	t	L
4	1/2	1/2	7/16	1	1/4	7/32	3/4
5	9/16	9/16	7/16	1 1/8	9/32	7/32	13/16
6	5/8	5/8	1/2	1 1/4	5/16	1/4	15/16
7	11/16	11/16	9/16	1 3/8	11/32	9/32	1
8	3/4	3/4	5/8	1 1/2	3/8	5/16	1 1/8
9	13/16	13/16	11/16	1 5/8	13/32	11/32	1 1/4
10	7/8	7/8	3/4	1 3/4	7/16	3/8	1 5/16
11	15/16	15/16	3/4	1 7/8	15/32	3/8	1 3/8
12	1	1	13/16	2	1/2	13/32	1 1/2
13	1 1/16	1 1/16	13/16	2 1/8	17/32	13/32	1 5/8
14	1 1/8	1 1/8	7/8	2 1/4	9/16	7/16	1 11/16
15	1 3/16	1 3/16	15/16	2 3/8	19/32	15/32	1 3/4
16	1 1/4	1 1/4	1	2 1/2	5/8	1/2	1 7/8
17	1 5/16	1 5/16	1	2 5/8	21/32	1/2	1 15/16
18	1 3/8	1 3/8	1 1/16	2 3/4	11/16	17/32	2 1/16
19	1 7/16	1 7/16	1 1/8	2 7/8	23/32	9/16	2 1/8
20	1 1/2	1 1/2	1 3/16	3	3/4	19/32	2 1/4
21	1 9/16	1 9/16	1 1/4	3 1/8	25/32	5/8	2 5/16
22	1 5/8	1 5/8	1 1/4	3 1/4	13/16	5/8	2 7/16
23	1 11/16	1 11/16	1 5/16	3 3/8	27/32	21/32	2 1/2
24	1 3/4	1 3/4	1 3/8	3 1/2	7/8	11/16	2 5/8
27	1 15/16	1 15/16	1 1/2	3 7/8	31/32	3/4	2 7/8
30	2 1/8	2 1/8	1 5/8	4 1/4	1 1/16	13/16	3 3/16
33	2 5/16	2 5/16	1 3/4	4 5/8	1 5/32	7/8	3 7/16
36	2 1/2	2 1/2	2	5	1 1/4	1	3 3/4

Contributed by Geo. W. Childs, MACHINERY'S Data Sheet No. 14. Explanatory note: Page 40.

TABLE GIVING DIMENSIONS OF PINS WITH COTTERS

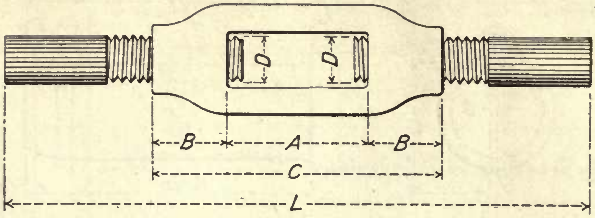


All dimensions in inches.

Diam. of Pin P	Pin: Diam. of Pin Hole	Pin: Taper at End t	Head: Diam. H	Head: Thickness T	Cotter: Length C	Cotter: Diam. D	Add to Grip: For Length M, over All M	Add to Grip: For Length L, under Head L	Diam. of Pin P
1	$1\frac{1}{32}$	$\frac{5}{16} \times \frac{1}{16}$	$1\frac{1}{4}$	$\frac{1}{4}$	$1\frac{3}{4}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{5}{8}$	1
$1\frac{1}{4}$	$1\frac{9}{32}$	$\frac{5}{16} \times \frac{1}{16}$	$1\frac{1}{2}$	$\frac{1}{4}$	2	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{5}{8}$	$1\frac{1}{4}$
$1\frac{1}{2}$	$1\frac{17}{32}$	$\frac{7}{16} \times \frac{3}{32}$	$1\frac{3}{4}$	$\frac{1}{4}$	$2\frac{1}{2}$	$\frac{5}{16}$	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{1}{2}$
$1\frac{3}{4}$	$1\frac{25}{32}$	$\frac{7}{16} \times \frac{3}{32}$	2	$\frac{1}{4}$	$2\frac{3}{4}$	$\frac{5}{16}$	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$
2	$2\frac{1}{32}$	$\frac{1}{2} \times \frac{1}{8}$	$2\frac{3}{8}$	$\frac{3}{8}$	3	$\frac{3}{8}$	$1\frac{3}{8}$	1	2
$2\frac{1}{4}$	$2\frac{9}{32}$	$\frac{1}{2} \times \frac{1}{8}$	$2\frac{5}{8}$	$\frac{3}{8}$	$3\frac{1}{4}$	$\frac{3}{8}$	$1\frac{3}{8}$	1	$2\frac{1}{4}$
$2\frac{1}{2}$	$2\frac{17}{32}$	$\frac{5}{8} \times \frac{5}{32}$	$2\frac{7}{8}$	$\frac{3}{8}$	$3\frac{3}{4}$	$\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$2\frac{1}{2}$
$2\frac{3}{4}$	$2\frac{25}{32}$	$\frac{5}{8} \times \frac{5}{32}$	$3\frac{1}{8}$	$\frac{3}{8}$	4	$\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$2\frac{3}{4}$
3	$3\frac{1}{32}$	$\frac{3}{4} \times \frac{3}{16}$	$3\frac{1}{2}$	$\frac{1}{2}$	5	$\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{8}$	3
$3\frac{1}{4}$	$3\frac{9}{32}$	$\frac{3}{4} \times \frac{3}{16}$	$3\frac{3}{4}$	$\frac{1}{2}$	5	$\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{8}$	$3\frac{1}{4}$
$3\frac{1}{2}$	$3\frac{17}{32}$	$\frac{7}{8} \times \frac{7}{32}$	4	$\frac{1}{2}$	6	$\frac{5}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$3\frac{1}{2}$
$3\frac{3}{4}$	$3\frac{25}{32}$	$\frac{7}{8} \times \frac{7}{32}$	$4\frac{1}{4}$	$\frac{1}{2}$	6	$\frac{5}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$3\frac{3}{4}$

Contributed by F. Geo. Walker, MACHINERY'S Data Sheet No. 95. Explanatory note: Page 40.

DIMENSIONS OF TURNBUCKLES



D = Normal Size = Outside diameter of screws,
A = Length in clear between heads = 6 inches for all sizes,
B = Length of tapped heads = $1\frac{1}{2}$ D,
C = Total length of buckle without bolt ends = 6 inches + 3D,
L = Total length of buckle and stub ends when open.

Size D, Inches	Length L, Inches	Weight of Buckle, Pounds	Weight of Buckle and Bolt Ends, Pounds	Size D, Inches	Length L, Inches	Weight of Buckle, Pounds	Weight of Buckle and Bolt Ends, Pounds
$\frac{3}{8}$	22	1	$1\frac{1}{2}$	2	29	14	35
$\frac{7}{16}$	22	1	$1\frac{3}{4}$	$2\frac{1}{8}$	29	17	41
$\frac{1}{2}$	22	1	2	$2\frac{1}{4}$	30	20	47
$\frac{9}{16}$	22	$1\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{8}$	31	22	53
$\frac{5}{8}$	22	$1\frac{1}{2}$	3	$2\frac{1}{2}$	32	25	61
$\frac{3}{4}$	23	2	4	$2\frac{5}{8}$	32	30	70
$\frac{7}{8}$	24	3	6	$2\frac{3}{4}$	33	33	78
1	25	4	8	$2\frac{7}{8}$	33	36	86
$1\frac{1}{8}$	25	5	11	3	34	40	96
$1\frac{1}{4}$	26	6	13	$3\frac{1}{8}$	36	45	108
$1\frac{3}{8}$	27	7	16	$3\frac{1}{4}$	36	50	120
$1\frac{1}{2}$	27	8	19	$3\frac{3}{8}$	37	57	134
$1\frac{5}{8}$	28	10	23	$3\frac{1}{2}$	37	65	150
$1\frac{3}{4}$	28	11	26	$3\frac{3}{4}$	39	74	168
$1\frac{7}{8}$	29	12	30	4	41	84	188

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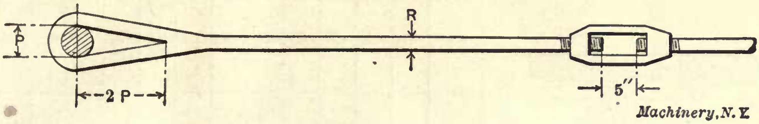
ALLOWANCE FOR EYE FOR ROUND AND SQUARE BARS



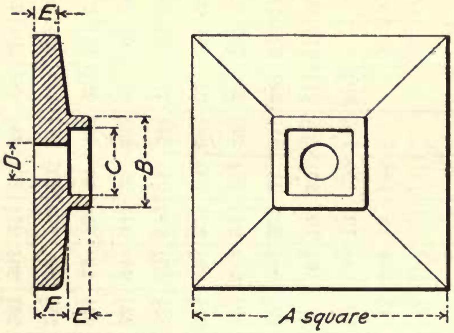
FORMULA:

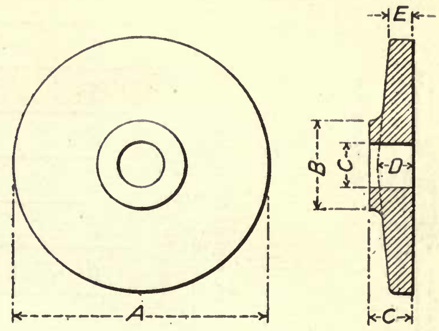
Length in inches beyond pin center, for forming one eye, equals 3.7 (P + R).

Diameter of Pin in Inches = P	Diameter or Side of Bar in Inches = R																		
	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3
1	6½	7	7½																
1¼	7½	7⅞	8⅜	8⅞	9¼														
1½	8⅜	8⅞	9¼	9¾	10¼	10⅝	11⅛												
1¾	9¼	9¾	10¼	10⅝	11⅛	11⅝	12	12½	13										
2	10¼	10⅝	11⅛	11⅝	12	12½	13	13⅜	13⅞	14⅜	14¾								
2¼	11⅛	11⅝	12	12½	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝						
2½	12	12½	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½				
2¾	13	13⅜	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜		
3	13⅞	14⅜	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼
3¼	14¾	15¼	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛
3½	15¾	16⅛	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24
3¾	16⅝	17⅛	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25
4	17⅝	18	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26
4¼	18½	19	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞
4½	19⅜	19⅞	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾
4¾	20⅜	20⅞	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝
5	21¼	21¾	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝
5¼	22¼	22⅝	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½
5½	23⅛	23⅝	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½
5¾	24	24½	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½	32	32⅜
6	25	25½	26	26⅜	26⅞	27¼	27¾	28¼	28⅝	29⅛	29⅝	30	30½	31	31½	32	32⅜	32⅞	33⅜

Contributed by W. J. Phillips. Explanatory note: Page 40.

SQUARE AND ROUND FLANGES



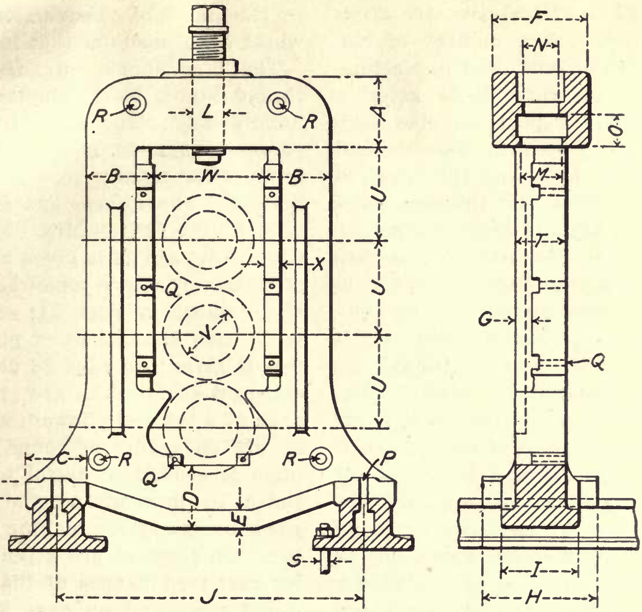


Diameter of Bolt	A	B	C	D	E	F
$\frac{1}{2}$	6	$1\frac{3}{8}$	1	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{3}{4}$
$\frac{5}{8}$	6	$1\frac{9}{16}$	$1\frac{3}{16}$	$\frac{11}{16}$	$\frac{1}{2}$	$\frac{3}{4}$
$\frac{3}{4}$	7	$1\frac{5}{8}$	$1\frac{3}{8}$	$\frac{13}{16}$	$\frac{5}{8}$	$\frac{7}{8}$
$\frac{7}{8}$	7	$1\frac{13}{16}$	$1\frac{9}{16}$	$\frac{15}{16}$	$\frac{5}{8}$	$\frac{7}{8}$
1	8	$2\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	1
$1\frac{1}{8}$	8	$2\frac{9}{16}$	$1\frac{15}{16}$	$1\frac{1}{4}$	$\frac{3}{4}$	1
$1\frac{1}{4}$	10	$2\frac{3}{4}$	$2\frac{1}{8}$	$1\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$
$1\frac{1}{2}$	10	$3\frac{1}{8}$	$2\frac{1}{2}$	$1\frac{5}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$
$1\frac{3}{4}$	12	$3\frac{5}{8}$	$2\frac{7}{8}$	$1\frac{7}{8}$	$\frac{7}{8}$	$1\frac{5}{8}$
2	12	4	$3\frac{1}{4}$	$2\frac{1}{8}$	$\frac{7}{8}$	$1\frac{5}{8}$
$2\frac{1}{4}$	15	$4\frac{5}{8}$	$3\frac{5}{8}$	$2\frac{3}{8}$	1	$2\frac{1}{8}$
$2\frac{1}{2}$	15	5	4	$2\frac{5}{8}$	1	$2\frac{1}{8}$
$2\frac{3}{4}$	18	$5\frac{5}{8}$	$4\frac{3}{8}$	$2\frac{7}{8}$	$1\frac{1}{8}$	$2\frac{3}{8}$
3	18	6	$4\frac{3}{4}$	$3\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{3}{8}$

Diameter of Bolt	A	B	C	D	E
$\frac{1}{4}$	$1\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{3}{16}$
$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{7}{8}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{1}{4}$
$\frac{1}{2}$	$3\frac{1}{4}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{7}{16}$	$\frac{5}{16}$
$\frac{5}{8}$	4	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$
$\frac{3}{4}$	$4\frac{7}{8}$	$1\frac{3}{4}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{7}{16}$
$\frac{7}{8}$	$5\frac{3}{4}$	2	1	$\frac{7}{8}$	$\frac{7}{16}$
1	$6\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{8}$	1	$\frac{1}{2}$
$1\frac{1}{8}$	$7\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{9}{16}$
$1\frac{1}{4}$	8	$2\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{8}$	$\frac{9}{16}$
$1\frac{3}{8}$	9	3	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{9}{16}$
$1\frac{1}{2}$	$9\frac{3}{4}$	$3\frac{1}{4}$	$1\frac{5}{8}$	$1\frac{3}{8}$	$\frac{5}{8}$
$1\frac{5}{8}$	$10\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$\frac{3}{4}$
$1\frac{3}{4}$	$11\frac{1}{4}$	$3\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{1}{2}$	$\frac{7}{8}$
2	13	$4\frac{1}{4}$	$2\frac{1}{8}$	$1\frac{5}{8}$	1

Contributed by Geo. W. Childs, MACHINERY'S Data Sheet No. 14. Explanatory note: Page 40.

PROPORTIONS OF CLOSED-TOP ROLL HOUSINGS



A — B x 1.08

B — U x 0.78

C — U x 0.65

E — U x 0.22

F — M x 2.00

G — U x 0.16

H — U x 1.25

I — T x 1.45

K — U x 0.25

L = U x 0.30

J — U x 3.5

D — B x 0.9 to B

M — L x 1.87

N — L x 1.54

O — L x 1.20

P — U x 0.11

Q — U x 0.04

R — U x 0.10

S — U x 0.075 + ¼"

T — U x 0.55

V — U x 0.6

W — U x 1.3

X — U x 0.125

Area of one leg should not be less than $U^2 \times 0.38$

SLIDES AND MACHINE DETAILS

On pages 25 to 39 inclusive are given tables and data for a number of machine details commonly used in machine construction. On page 25 is given a table of machine V-strips or gibs such as are commonly used in machine tool construction for providing the required adjustment of slides. On the same page is also given a table of brass flanges designed to resist 250 pounds pressure per square inch. On pages 26 to 29, inclusive, are given dimensions for machine slides with four different kinds of strips or gibs. No additional explanation is required for these tables. On page 30 are given four tables for ball-cranks and handles of the type commonly used on machine tools and of suitable proportions for ordinary designs. On page 31 is shown a design of safety set-screw collar, cored out or counterbored on the outside diameter for the head of the set-screw. On pages 32, 33 and 34 are given dimensions for hand-wheels of various designs. The type shown on page 32 is especially used in machine tool construction, the hand-wheel being made of cast iron.

The type shown on page 33 is the United States Navy standard for brass hand-wheels. The table in the lower part on page 32 gives proportions of grooves for manila rope for large rope pulleys. The dimensions as given are used by the Jeffrey Mfg. Co., Columbus, Ohio. On page 34 is given another table of collars of a type somewhat similar to those shown on page 31; on page 35 a table with dimensions of pins with cotters is given; on page 36 dimensions of standard turnbuckles are given, and on page 37 a table of allowances for forging an eye on square or round bars. This table is especially useful to the blacksmith in determining the amount of stock necessary for making an eye in a bar. On page 38 are given dimensions for cast iron flanges of the square and round type, and on page 39 are given proportions for closed-top roll housings. The formulas given are based upon the center distance between the rolls.

No. 16. Machine Tool Drives.—Speeds and Feeds of Machine Tools; Geared or Single Pulley Drives; Drives for High Speed Cutting Tools.

No. 17. Strength of Cylinders—Formulas, Charts, and Diagrams.

No. 18. Shop Arithmetic for the Machinist.—Tapers; Change Gears; Cutting Speeds; Feeds; Indexing; Gearing for Cutting Spirals; Angles.

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No. 30. Locomotive Design, Part IV.—Springs, Trucks, Cab and Tender.

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No. 32. Screw Thread Cutting.—Lathe Change Gears; Thread Tools; Kinks.

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